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AGRICULTURAL ENGINEERING

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The Problem of Distribution of Air in Curing Long Hay — *Arthur W. Clyde*

Equipment Needed for Handling Partially Cured Hay — *C. N. Turner*

The Curing of Hay in the Stack by Means of Forced Air — *J. H. Ramser, E. W. Lehmann*

Resistance of Hay to Air Flow and Its Relation to Equipment Design — *C. K. Shedd*

Rotary Soil Tillage — Some Engineering Developments — *C. W. Kelsey*

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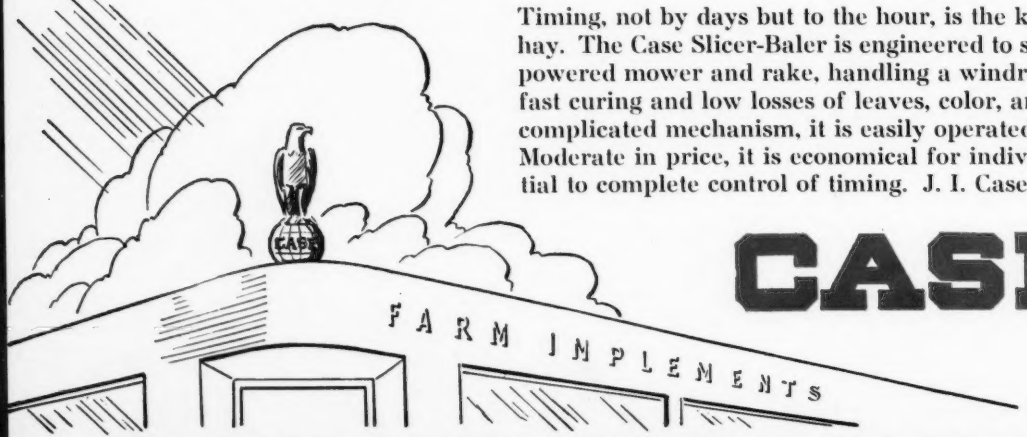
35 Years of Knowing How

Brought the Slicer Baler

A Big Future in Forage Machinery

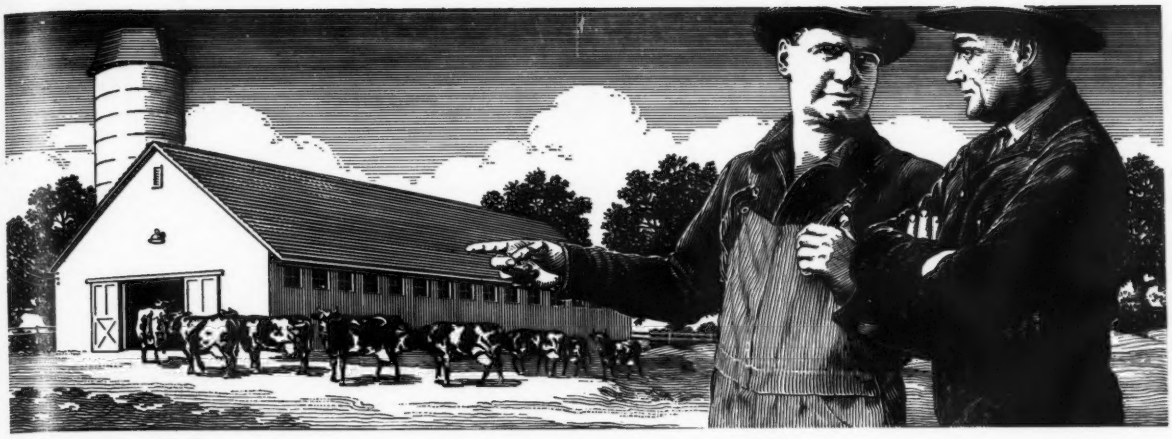
In the years since 1910 Case has built many balers of varied types — stationary, portable, and pick-up; powered by horses, belt, and engine. Case also has built mowers, rakes and loaders, not to mention machines for harvesting and for sowing the seeds of forage crops. For years the Case purpose has been not only to put quality into hay machines, but to get quality in hay.

Timing, not by days but to the hour, is the key to highest quality in hay. The Case Slicer-Baler is engineered to stay in step with tractor-powered mower and rake, handling a windrow of optimum size for fast curing and low losses of leaves, color, and carotene. Free from complicated mechanism, it is easily operated by average farm help. Moderate in price, it is economical for individual ownership, essential to complete control of timing. J. I. Case Co., Racine, Wis.



CASE

HEADQUARTERS FOR FARM EQUIPMENT TO APPLY THE ADVANCED PRACTICES



"They're eating me out of house and home," SAID JACK ANTHONY
"Maybe they need more grass," SAID THE COUNTY AGENT

• Jack Anthony had always run a dairy for somebody else before he bought his own place spring before last.

One of the first things he did was to start keeping a set of herd records.

He got good production from the start. But, at the end of two months, he figured he was buying a pound of grain for every six pounds of milk he got.

Late that summer, the County Agricultural Agent stopped by Jack's barn lot.

"How're they doing, now they're used to this barn?" asked the County Agent.

"They're giving lots of milk all right," Jack said, "but darned if they don't eat up the milk check every month!"

That started the County Agent to talking about growing grass to cut down feed costs. He told Jack how pasture improvement was paying good dividends to farmers around the county. And he said he'd be glad to help Jack set up a pasture program.

That fall Jack Anthony fertilized his whole pasture. The next spring he disked the parts that were fairly level and seeded them with oats and a Ladino-clover and grass mixture the County Agent recommended. Around each of these "islands" he put a temporary fence.

The fertilizer he'd used made those oats get up and go. And he turned his cows in on them about the first of June. After they'd grazed off the oats, he took them out for a while to let the clover and grass get a good start. And then he took down the fences and let his cows graze over the whole pasture.

Last fall Jack Anthony saw the County Agent at the bank and told him he was buying only one pound of grain for ten pounds of milk because his cows were getting so much out of his improved pasture.

"You can really count on a pasture improvement program to set a full table for your cows," said the County Agent.

"And you can always count on the advice that you get from a County Agent to help you farm better, too," said Jack Anthony as he shoved his milk check through the teller's window.

All over the country, farmers are getting help from their County Agents that makes farming *better* and *easier*.

Another thing that good farmers are doing to farm better and easier is to make full use of electricity.

The Modern Farm is an Electric Farm!

Electricity on the farm can make life more pleasant and work easier.

If you don't have electricity, get in touch with the electric service supplier in your area.

If you already have electricity, get your full value out of it by making it do more jobs for you.

To help build up modern farms electrically continues to be the job of the G-E Farm Industry Division.

GET BETTER GARDEN CROPS WITH CONTROLLED RAIN

Farmers, even in humid areas, report that watering garden crops during dry spells often accounts for a 100-per cent or better increase in yield.

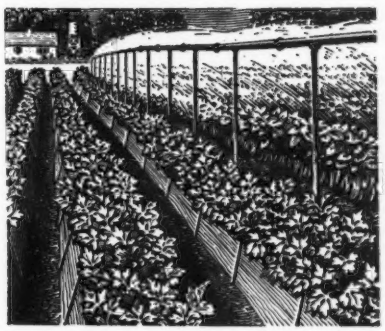
And they get better truck, flower, or small-fruit crops by supplying them with water when they need it.

Sections which have 60 inches of rainfall or better annually often experience short periods of drought in normal years. When these dry periods occur during the growing season, plants are set back and produce small, inferior yields. A little water at the right time can mean the difference between a bumper crop and a failure.

Your farm water supply may be adequate to supply irrigation for a small family garden plot during dry spells. But for larger truck, berry, or commercial flower plots a separate water supply is usually necessary.

Whatever your source of water—shallow or deep well, lake or stream—there is an electrically driven pump to fit your needs. It will provide water under pressure whenever you want it. At the snap of a switch, you can have automatic pumping that's quiet, requires practically no attention and, with G-E motor and control, very little maintenance.

When you get your electric water system, be sure to specify a G-E motor and control for the pump. Built for rugged farm service, they are protected against dirt and falling objects. They'll give you many years of dependable, economical operation. *Farm Industry Division, General Electric Co., Schenectady 5, N. Y.*



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AGRICULTURAL ENGINEERING

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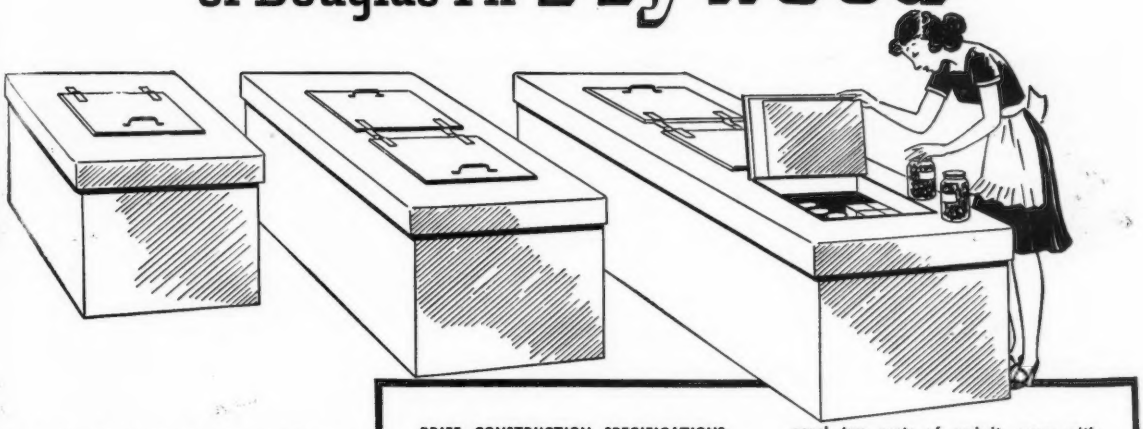
Home-Built Farm Freezers of Douglas Fir Plywood



Frozen food storage is very much in the farmer's mind these days!

Several market surveys have been made recently of the buildings and equipment farmers plan to install as soon as materials become available. These indicate that 20 per cent or more plan to enjoy the convenience of a freezer in their homes.

Building a simple design of freezer cabinet is not difficult, but it does require careful, intelligent workmanship. The three freezers illustrated can be built by anyone with a reasonable amount of mechanical skill, the ability to understand plans and specifications, and adequate tools. With the exception of the cooling coil it is not practical to construct the mechanical refrigeration unit. This item and the necessary controls must be obtained from a commercial supplier and should be connected to the box by a skilled mechanic.

Plywood is an excellent material for the construction of such boxes because the large panels permit one-piece wall coverings. It is easy to fabricate, lightweight, sturdy and durable, and stiffens the assembly so that less framing is required. There is no odor from plywood to taint the food. The smooth surfaces take paint and moisture-vapor proofing coatings readily, and give an attractive, sanitary appearance to the completed job.

The freezers shown are of the chest type, with top opening lids and a single interior compartment for freezing and storage. They are designed with a removable top section. When this is off the boxes may be turned on edge and carried through a 30-inch doorway.

The three chest sizes have net storage volumes of 12, 21 and 30 cubic feet, respectively. The approximate storage capacity in frozen food ranges from 350 to 1400 pounds. The refrigeration requirement is for a 1/4 horsepower compressor on the smaller box, and 1/3 horsepower units on the two larger sizes.

BRIEF CONSTRUCTION SPECIFICATIONS

FRAMING. Simple 'run-around' frame for each wall, top and lids with intermediate stiffeners. Lumber must be dry and straight, of a clear grade and of a species which does not split readily. Use 1" boards accurately milled to 5½" for walls and bottom, and to 3½" for top and lids. Nail wall and top frames together as individual units.

OUTSIDE SHEATHING. Use ½" EXTERIOR-type plywood panels. Cut out openings in top panel for lids.

MOISTURE VAPOR BARRIER. Apply two coats odorless asphalt paint to inner surface of panels and to outer edges of frames. Press sheets of special odorless and tough vapor-proof paper onto wall and top panels and nail to frames.

CONNECTION DUCT. Install duct for refrigeration unit connection in one end wall section.

INSULATION. Pack frames with insulation material and nail inside fiberboard sheathing in place.

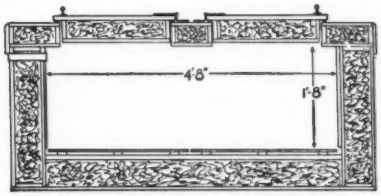
BOX ASSEMBLY. Apply two coats of asphalt paint to contact areas at ends of wall sections, place strip of felt between to help form airtight joint, and nail sections permanently together to form rigid wall unit.

Turn unit upside down, and nail bottom framing members in place. Pack insulation in bottom section. Paint bottom plywood panel two coats of asphalt, cover with vapor-proof paper as in wall sheathing, and nail to freshly asphalted edges of framing.

Reverse box to normal position. Drop bottom plywood panel into position and nail. Install water-tight metal pan in bottom, and nail inside plywood sheathing in place to lap over top edges of pan.

INSIDE FINISH. Give inside plywood wall and lid surfaces two coats of spar varnish.

COOLING COIL. Place coil in box and connect to refrigeration unit.



Longitudinal section of 21 cu. ft. box

TOP. Place top panel in position on box with felt between contact surfaces and fasten with trim around top edges. Install lid hardware, and place slat bottom racks on metal pan. Set box on 1" strips above floor.

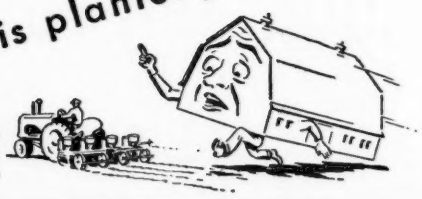
PAINT. Give all exterior surfaces three coats of exterior paint or enamel.

Estimated material costs, including the refrigeration unit, range from $200 to $350.

The freezers were designed and tested under both laboratory and farm use conditions by the Division of Agricultural Engineering, University of California. Complete working drawings and specifications for each size—Plan C-103 12 c. f., Plan C-104 21 c. f., and Plan C-105 30 c. ft.—are available from the Agricultural Extension Service, University of California, Berkeley, California, at a cost of 26 cents per plan. Kodachrome slides and 16 mm. motion picture film showing construction of the 21 c. f. freezer are available on loan from Douglas Fir Plywood Association, Tacoma Building, Tacoma 2 ,Washington.

DOUGLAS FIR PLYWOOD
LARGE. LIGHT. STRONG.
Real Wood PANELS

Has his barn caught up with his planter?



A farmer with a planter can put in a corn crop 10 times as fast as Grandad could! . . . But how much faster does he do his chores? If he's still doing them "the hard way" it's time to modernize with Jamesway. Here's why . . .

Save time, save steps, save work with Jamesway LEVER STALLS.
Step up milk, butterfat output 5 to 10% with Jamesway WATER CUPS.
Make one step do the work of 16 with a Jamesway FEED CART.

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Farmers save hours and hours of chore time with Jamesway barn equipment . . . get more done — with less effort. And they find that Jamesway "Chore Savers" help step up production, increase livestock income too.

Typical of the Jamesway Line is the lever stall. One lever locks all the cows in place. No walking in and out past every cow. Release them just as easily. A hundred steps saved every day!

Write for a copy of the new Jamesway Farm Building Book. You'll want a copy before you make any suggestions for building or remodeling any farm building. It's packed with time-saving, labor-saving, money-saving ideas.

It's easy to modernize the Jamesway. It can be done gradually at surprisingly little cost. Your local Jamesway dealer will be glad to cooperate with you in helping farmers work out their plans. Get acquainted with him. For the farm building book, write to department A-446.

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EDITORIAL

Engineering the Castor Bean

REVIVAL of the subject of castor beans at the Farm Chemurgic Conference last month emphasized the fact that their development as a profitable crop in North America awaits only agricultural engineering development of satisfactory harvesting equipment.

Large industrial markets exist and have excellent prospects of continuing. Castor oil is, in fact, a strategic material. At present the commercial supply of beans is imported from Brazil, where they are gathered by hand, by necessarily cheap labor. Buyers would prefer a domestic supply if it were available. Experimental work and sporadic commercial development of domestic production antedates the year 1850. Quality of the domestic bean is entirely satisfactory. A large area in which quantity yields are satisfactory has been defined. Few plant diseases or insect pests interfere with production. The only factor limiting domestic production to practically nil is production cost, and in it harvesting is the critical item.

Acknowledgment was made that several agricultural engineers have done some excellent work on this problem. Specially adjusted combines have shown promise in some experiments. Work is continuing on development of a stripper.

Plant characteristics which have complicated the harvesting problem include the tough and heavy plant stalk; the fact that the beans grow in small bunches scattered about the plant, usually close to the main stem and hidden by large leaves; the tendency of the pods to ripen individually over an extended period; the tendency of the pods to explode and scatter the beans when ripe; difficulty of removing the beans from pods harvested green enough to prevent shattering; and rapid deterioration of the oil in the bean itself when the bean hull is cracked before it reaches the extraction mill.

Plant breeders may be able to develop varieties better adapted to mechanical harvesting. It appears that the theoretical ideal from this standpoint would be a thin-stemmed plant not over 3 or 4 ft tall, on which a good yield of beans would mature at the same time in large or closely grouped bunches of non-shattering pods. Early prospects for reasonably successful harvesting equipment would probably stimulate more work on plant adaptation.

One or more machines which are fairly successful in removing beans from unshattered pods are reported to be available. The major unsolved problem is that of gathering a large proportion of the ripened beans from the plant at a reasonable cost.

Early solution of this problem might well be scheduled as an agricultural engineering "must" from several standpoints. For farmers in the Ohio and Mississippi valleys and adjacent potential producing areas, it means several millions of dollars of increased annual income. From a national standpoint it means local security and independence as to one more strategic material, plus opportunity for increased industry, employment, and national income, as well as improved products. From a more broadly social viewpoint, there may be considerable merit in removing an incentive for continued peonage in a neighboring country.

There may be one or more agricultural engineers who have not been working on this problem, who can contribute something to its solution, and some others who, with more encouragement, could do more toward its early solution. Can we get this problem out of the way, and production under way? Isn't the problem too tangible; the opportunity too evident; and the responsibility too directly in the field of agricultural engineering to warrant any further delay?

Farm Pressure for Hay-Drying Progress

WE always find it refreshing and challenging to find a farmer who shares the engineering viewpoint on operating methods and economy. One such farmer is Harold Anderson, of Lucas County, Ohio, who at the A.S.A.E. sponsored barn hay-curing conference at Purdue University in January reported on his seven years of hay-drying experience.

He has entered wholeheartedly into the give-and-take of information on hay-drying. He has adapted and improved on experimental equipment and methods, and developed some of his own worthy of engineering note. But what is most noteworthy is that, while pleased with his results so far, he sees the need and opportunity for further improvement, has analyzed the economic and physical factors, and has a revised procedure under development for test during the coming summer.

In engineering matters, as applied to his own operations, no one has to lead him by the hand, and it may be some trouble to keep up with him. We commend his paper, published elsewhere in this issue, both as a substantial contribution to the practice of hay drying and as an action study in farm application of agricultural engineering principles and developments.

Engineering's Economic Environment

AN "off the record" question in the correspondence of one of our leaders in agricultural engineering research recently impressed us as digging toward some new fundamental concepts.

Noting that "economics dominates the decisions of engineers," that "our price system is based on scarcity," and that "our engineering objective is to produce more abundantly," he asks, "How long will our economic decisions be valid as we approach our goal of abundance?"

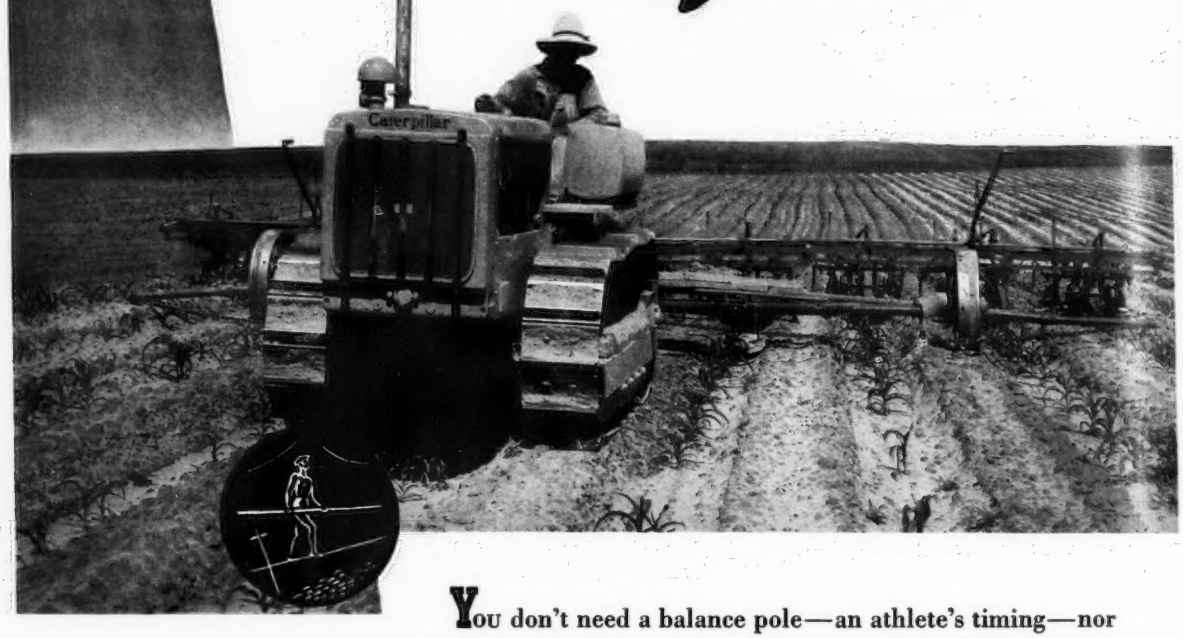
This is a timely question, in the sense that thinking a few years ahead is always timely in engineering. We may well remember that in the decade of the 1930's we were face to face with this question. Many of our economic decisions had proven invalid. There was little agreement and much costly confusion as to what economic concepts remained valid, what ones should be thrown on the scrap heap, and what new ones might do for replacements, at least for a few years.

We may well remember, too, that we had not yet solved this problem when the waste of war brought us, not a solution, but a temporary return to the conditions of scarcity in which our old economic concepts worked fairly well.

With our return to peacetime production we have every reason to anticipate a return of our former problem in abundance economics. It may return with renewed force unless new concepts are developed and allowances made in our present period of reconversion. Contributing factors include temporary backlog demands, already strained government credit, war-born increases in production capacity, and disturbed international trade demands and buying powers. *(Continued on page 170)*

"TIGHT-ROPE" ACT

Transformed!



You don't need a balance pole—an athlete's timing—nor a lot of luck—to keep a "Caterpillar" Diesel Tractor on listed row-crop ridges. For this tractor, by nature and design, transforms what many farmers call their "tight-rope act", into a simple, easy job.

The 44-inch gauge Diesel D4 (or the 40-inch gauge Diesel D2) neatly fits standard listed-crop spacing. Long and wide, the tracks with sure traction hold their position like planks. A gentle tug on a convenient steering lever gets instant, accurate response—gives the operator positive "direction-control" through heavy-duty steering clutches, as designed and developed by "Caterpillar".

The Diesel D4 shown here is pulling a hitch of three 3-row listed-crop cultivators—cultivating 10 acres of listed corn per hour. Such capacity—teamed with proved Diesel economy—puts Great Plains listed row-crop production on a highly favorable basis!

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AGRICULTURAL ENGINEERING

VOL. 27 APRIL, 1946 No. 4

Distribution of Air in Long Hay

By Arthur W. Clyde

FELLOW A.S.A.E.

AN examination of barn hay drying systems in operation will probably convince us, if we are not already convinced, that we often have uneven distribution of the air flow through the hay. The ideal condition would seem to be to have all air become nearly saturated before it leaves the hay. Air which escapes long before it has reached that condition is largely lost, and the energy put into blowing it is also largely lost; in fact, it will be referred to as a loss in this paper. In general, good air distribution is needed to dry all the hay quickly with a minimum amount of power and blowing cost. Very poor distribution may result in spoilage of part of the hay; in fact, that has occurred in cases under our observation.

It is fortunate and logical that this discussion follow those of Messrs. Frudden, Hendrix, and Shedd. Distribution of air is inseparable from the resistance which the hay and the ducts offer to air flow. Reduced to simple terms, the problem of distribution is how moving air will divide when it is offered two or more paths of unequal resistance and area.

With parallel circuits, a direct current of electricity will divide in inverse proportion to the resistances, and at any instant the resistance in each path is a fixed amount. In water pipes and air ducts, however, no such fixed resistance exists. We must deal with *resistances,* instead of with *a* resistance because the resistance changes with the flow. In such a case the measurement of resistance is not a positive unit like the ohm in electrical work. With air and water flow the resistance is given in terms of the pressure required to maintain some certain flow.

This fact, often overlooked, has resulted in meaningless information being circulated. For example, the resistance may be given for a duct system with no hay on it and with no information about the amount of air flow. In other cases the resistance with no hay may be given together with the resistance with hay on the ducts, yet the air flow may have been greatly different for the two conditions. A figure on resistance to air flow has no meaning unless the rate of flow is given with it.

With our limited knowledge of air flow through hay, we do not progress very fast in attempting to calculate how air flow will divide among paths of unequal resistance and area. Probably all will agree that the resistance to flow in a duct or through a fixed orifice is proportional to the square of the velocity. But with hay there is considerable experimental evidence that the resistance increases at a lower figure than this. We have such evidence from tests with a laboratory setup, and I understand A. T. Hendrix also has such evidence. I am told that air flow through filters may not follow the square law. Perhaps the higher velocities cause some displacement of material and enlarge the air passages. Until we know more about how the resistance varies with velocity, we can figure only approximately on how the air flow will divide among different paths. For this reason, the remainder of this discussion must be approximate rather than exact.

Distribution of air is probably the No. 1 problem in most Pennsylvania barns, and this applies also to several of the northern states. Our typical barn is a high one, divided into mows 18 to 20 ft wide, with a barn floor between the mows. Common practice is to fill one mow to

This paper was presented at the barn hay-curing conference sponsored by the Committee on Hay Harvesting and Storage of the American Society of Agricultural Engineers, at Lafayette, Ind., January, 1946, and was authorized for publication March 18, 1946, as paper No. 1319 in the Journal Series of the Pennsylvania Agricultural Experiment Station.

ARTHUR W. CLYDE is professor of agricultural engineering, Pennsylvania State College.

Fig. 1 *(Left)* Apparatus for studying air flow through hay. The lower section at the right is removable for changing the manner of admitting air to the hay without disturbing the main body of hay • Fig. 2 *(Right)* A 3-duct system in a hay mow 19½ ft wide. The center duct is set 4 in above the floor under the hay carrier and 3 in elsewhere. It also has cracks in the top but more cracks are now believed desirable

the top and then start filling another. In many the hay will be 15 to 20 ft deep, with a greater depth in some. If a man is willing to put a mow and a barn floor together to get a larger area for the drier, and keep the depth of hay to a lower figure, then air distribution is simplified. The difficulties mount up in narrow deep mows if all air is admitted through ducts built on the floor. One side may not be enclosed at all. The other sides may have numerous cracks and practically always have timbers or studs which prevent close contact between hay and wall. Any air reaching the sides can escape freely or has a rather easy path up the wall. A smooth tight wall permits higher velocity next to the wall than exists through the hay elsewhere, and most walls with projecting members are much worse than a smooth wall. A wall with vertical studs next to the hay is probably little better than no wall in preventing air escape out the sides. Often no instruments are needed to detect that much air is escaping out the sides, a distinct flow there being easy to feel. Certainly we cannot expect all the air to go up through 15 to 20 ft of hay when it can escape by going only 3 to 6 ft horizontally.

Measuring Air Distribution. So far our means of measuring how much air leaves the hay at various points are rather crude. The most used method seems to be a funnel with the large end next to the hay and an anemometer at the small end. This gives rough comparisons, but it needs to be calibrated carefully to give results of quantitative value. For example, we have used one with a ratio of 20 to 1 of area for the large and small ends of the funnel and have tried it with the laboratory setup where we are sure we have an average flow of 15 cfm per sq ft (face velocity of 15 fpm). Instead of showing 300 fpm the anemometer has shown one-third to one-half that velocity. The discrepancy is no doubt due to the restriction added by the funnel and anemometer, this restriction causing some air to bypass the funnel. F. W. Duffee considers an area ratio of 10 to 1 better than 20 to 1. Mr. Hendrix tells me he is attempting to calibrate his apparatus so that he will have the relation between the anemometer reading and the actual face velocity. There is considerable doubt as to how reliable this apparatus is when breezes are present. For this reason it is probably best to rely on it only when little wind is blowing.

The velometer in its present form appears to be of little value in detecting the low velocities which we wish to study. It is adapted to higher velocities but perhaps some adaptation of it might be possible.

SMOKE USED TO GET VISUAL INDICATION OF AMOUNT OF AIR COMING OUT OF THE HAY

We have also experimented with smoke to get a visual indication as to amount of air coming out of the hay. So far the results have been discouraging. The difficulty is to get enough smoke to be useful on a laboratory scale, to say nothing of a barn installation. We have tried sprinkling ammonia water on the hay surface, then going over the surface with a small tube feeding sulphur dioxide. This method does not appear to be promising. If anyone has had success with smoke I would like to know about how it was done.

Causes of Uneven Distribution. One of the causes of uneven distribution of air is uneven density of the hay when hay is dropped from a carrier. Regardless of how much advice is given on this, I do not see how packing can be avoided where the hay is repeatedly dropped, and in the spots where men have to stand much of the time when moving the hay. One place or the other is almost certain to be a place which air will avoid, making a critical area for drying. In one case we found a density of 8.4 lb per cu ft under the hay track after the hay was dried. This lot of alfalfa was put in with an average moisture of 58 per cent, which of course is far too high to secure any capacity. Two farmers in Pennsylvania have done something about this. They have built platforms upon which the hay is dropped and from which they distribute it. A timber placed to break the fall of the hay probably helps. Perhaps a hay carrier which lowers hay gently may be devised.

We have high hopes that blowing uncut hay into the mow will make for more even density as well as leaving the hay loose and easy to blow air through.

The other common cause of poor air distribution has already been mentioned, namely, short paths of low resistance out the sides. Some slotted floor systems have been put in as close as 2 ft to a wall or open side. Most public institutions are now recommending that ducts be stopped either 5 or 6 ft from the sides. Where a duct runs parallel with a wall, recommendations vary from 3 ft 4 in to 5 ft, though it is hard to see why this distance should be any less than the other. Most of us have avoided saying whether the walls should be tight or whether a wall should be built if none exists. Also, as far as I can learn, nobody specifies whether a wall should be smooth next to the hay. One college advises that an open side should be enclosed half way up; another says, privately at least, that they consider a wall of little value for preventing side losses. At my own institution with a mow 20 x 35 ft, we enclosed an open side with a smooth wall 6 ft high. There is some loss there, but I am sure it is not as great as with no wall. When sections of this wall were removed, a strong flow outward could be detected with a reduction of pressure in the duct nearby.

LABORATORY SETUP USEFUL FOR CERTAIN TESTS ON THE DISTRIBUTION OF AIR THROUGH HAY

Fig. 1 shows a laboratory setup for studying the resistance which hay offers to air flow, also the resistance offered by the duct opening and the adjacent hay in which the air is spreading out. It is also useful for certain tests on air distribution. Perhaps exact values from it cannot be carried over into full-size driers, but it permits work to be done which cannot be done elsewhere.

The main part is a section approximately 4 ft square and 8 or 10 ft high. This is filled with hay at the desired density, this hay being supported only by a coarse wire screen at the bottom. A plenum chamber about 10 in deep is added below and air is blown into it. Air is measured by orifices in the fan intake. These are bell-mouthed orifices, the coefficients of which are well established. Two sizes were selected so that at common air density, a 1-in water vacuum would give air flows, respectively, of 5 or 10 cfm per sq ft of hay area. Three orifices and 1-in vacuum furnish flows from 10 to 25 cfm per sq ft, and with more vacuum we can go to 35 cfm per sq ft or more. This method of air measurement is much easier and quicker than a pitot tube, and, I believe, more accurate. The blower is driven through a variable-speed V-belt drive.

In practice we first get the resistance at various air flows through the hay with a minimum of support. The plenum chamber is then removed and some kind of duct or slotted floor added. This is covered with hay, put into place below the main hay section, and tests again run. The resistance thus added is called the entrance resistance to separate it from that in the main part of the hay. Without going into detail, it may be noted that these tests show a high entrance loss with chopped hay and the common duct with a 1-in crack. A 2-in crack is better but is not twice as good. Neither is a 3-in crack three times as good.

This apparatus is mentioned mainly because it was used to check on the value of walls. With a hay depth of 8 ft,

one side of the hay container was removed. Air was admitted at the bottom of the opposite side, the nearest exit being 3¾ ft away. The funnel and anemometer then detected no flow out the top of the hay. All of the flow it could detect was in the lower 4 ft of the open side, the greatest velocity being at the bottom. The pressure required to cause a certain flow was approximately half the pressure needed to send all the air up through the 8-ft column.

Possible Improvements. Most of this discussion will relate particularly to narrow deep hay mows, 18 to 20 ft wide and 12 ft or more deep. Some of the items mentioned, however, apply also to wider mows. The word "duct" will be used for both the conventional duct and the passages of a slotted floor system since, for this discussion, they are practically the same.

One possible line of attack is to keep the ducts farther away from the walls or sides of the hay. A possible distance from ducts to walls of 8 ft might be suggested. This might be an improvement, but certain dangers connected with it would have to be avoided. In a mow 20 ft wide this would leave a width of only 4 ft for the ducts. The 4 ft might all be required for the main; thus all air would have to be admitted to the hay from the main. A very large amount of cracks or exit openings would seem needed to avoid a high-entrance resistance when all air must go through the small amount of hay in contact with the duct. When only a few feet of hay are on the drier it will probably be necessary to pile most of it over the duct; otherwise most of the air would escape upward from the duct, and hay near the outside would spoil. It must also be remembered that, when the mow is full, the 8-ft distance to the sides is a shorter path than the path to the top of the hay. This general method has the drawback that it might be fairly good for one certain depth of hay but not so good for a lesser or a greater depth.

A variation of the above method would be to extend parts or all of the duct up 6 or 8 ft above the floor, with the plan that most of the air would go out to the sides. Much air is now going out the sides and this idea is to take advantage of that. Some precaution would of course be needed to prevent top losses when the duct has little depth of hay over it.

A second line of attack might be to build resistance into the duct system with the idea of reducing the loss of air in case some easy path of air exit should exist through the hay. Built-in resistance has been discussed very little publicly, but I know that some men have thought of it and perhaps believe it has some merit. I think the basic trouble with built-in resistance is that it increases the power needed to circulate a certain amount of air. There is serious question whether we can afford this penalty when the power is definitely limited, for instance, to a 5-hp motor. A much more promising way is to throttle the air only to the parts of the ducts from which it is known that air can easily escape, all other parts of the system having a minimum of resistance. For example, the parts of the ducts nearest the walls might be restricted or throttled so that the pressure would be distinctly lower there than in the main part of the system. This is an attractive possibility for reducing losses out the sides, particularly in mows wider than 20 ft. It is being tested. (See paper by Andy T. Hendrix on page 113 of AGRICULTURAL ENGINEERING for March, 1946.)

Fig. 2 shows our drier which uses this principle of throttling. The central duct was planned to be large enough to take the entire flow if desired. The small ducts on each side are equipped with gates so that the air going to them can be throttled or shut off entirely. One weakness of this arrangement in a narrow mow is that the side ducts reduce the actual distance through hay from the center duct along the floor to the outside. Side losses must be expected even though the side ducts are shut off. It may be interesting to note that we handled four lots of hay on this drier last summer, the first three lots being removed when they were dry to make way for more trials. One lot of hay was filled to a depth of 14½ ft in two stages.

The final suggestion for improvement is that of two-level ducts. It seems wrong to attempt to blow air through 15 or 20 ft of hay just to dry the last foot. If that could be avoided, we could hasten drying by blowing more air or we could handle more hay with the same power now being used. We know that a two-level duct system was tried in early Tennessee experiments and that it did not seem practicable then with wood ducts. Perhaps now the idea ought to be revived; sheet metal or wire mesh ducts may lend themselves better to such use than wood. Certainly it seems that some way might be devised so we could avoid the resistance encountered in blowing air through great depths of hay, also so we could avoid the overdrying of hay which is already dry enough to keep safely.

Discussion by George E. Zerfoss

THE problem of getting equal distribution of air through hay is an important one, particularly at depths of hay exceeding 6 to 8 ft. In some of the present hay-drier designs there is considerable loss of air along the floor and out the sides of the mow. In other words, a considerable portion of the air delivered by the fan is not being forced up through the mass of hay. To improve this condition we have designed and tested several types of floor laterals, with enlarged openings at their junction with the main air header and with open sides. Actual tests, in drying hay at depths of 10 to 12 ft, have shown this type of lateral to be an improvement over the conventional closed-side lateral in regard to air distribution.

To determine more specifically the relationship between points of discharge of air from the duct system, its horizontal and vertical movement, and uniformity of discharge from the hay mass, a hay drier was built with hinged boards on both sides of the main air header, which could be manually opened and closed. Such a design was suggested by H. D. Bruhn, research agricultural engineer, University of Wisconsin. Open-side lateral ducts were provided at the mow floor level. Air from the fan could be admitted to the hay either through these openings in the main header or through the lateral ducts, as desired. Nine feet of partially cured lespedeza hay was loaded on this system, and with the fan delivering 16 cu ft of air per square foot of mow area, static pressure readings were taken over the whole mow from top to bottom at 1-ft intervals. A 10-ft length of ⅛-in pipe, with static pressure holes drilled 4 in from the end, was used to obtain these readings. An inclined water gage, attached to one end of the ⅛-in pipe, indicated the static pressures at various depths in the hay. Parallel tests were made, one test with the sides of the main air header closed and floor laterals open, and another test with the sides of the main air header open and floor laterals closed.

Results of Tests. Curves plotted from data obtained showed lines of equal static pressure at different depths of hay over cross sections of the mow. These curves indicated considerably less loss of air out the sides of the mow at a 9-ft depth of hay, when air was admitted from the main duct only, than when air was admitted from the lateral

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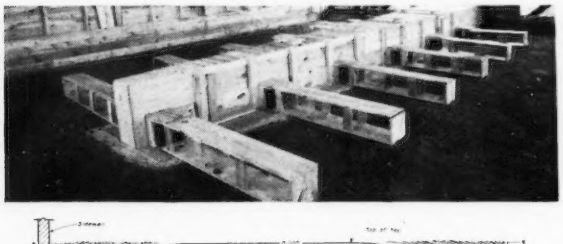

Fig. 1 *(Top)* Hay drier duct system with lateral ducts open and sides of main header closed. *(Bottom)* Cross section of hay mow showing lines of equal static pressure (in inches of water) in the hay

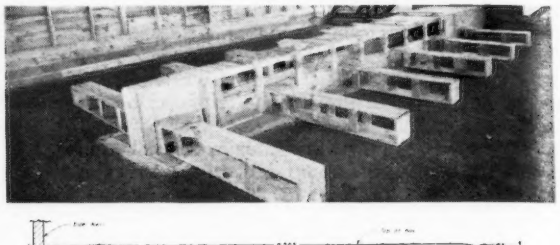

Fig. 2 *(Top)* Hay drier duct system with lateral ducts closed and sides of main header open. *(Bottom)* Cross section of hay mow showing lines of equal static pressure (in inches of water) in the hay

ducts. It is believed that further tests in the actual drying of hay on this system will show a decided improvement in getting more equal distribution of air through hay at depths exceeding 6 to 8 ft.

What Is an "Agricultural" Engineer?

To the Secretary of A.S.A.E.:

I DON'T make a practice of writing letters to the editor, but reading the report of the Subcommittee on Industry Requirements of the A.S.A.E. Committee on Curriculums, beginning on page 504 of AGRICULTURAL ENGINEERING for December, has left me so confused that I need to write down some of this confusion in an attempt to clarify my own thinking.

I am aware that there has been a great deal of discussion over what an agricultural engineer is. Apparently the Society officially does not know yet, or, if it does, that fact is not clear to me. I have discussed the implications of this report with several other members of the Society, with whom I have personal contact, and have found some of their reactions, in varying degrees, similar to mine. Each of them, without exception, immediately started in with his own explanation of how the report happened to be what it is.

I am not thinking of the proposed curriculum or its content because the premises on which it is based are sufficiently unclear to me so that I am unable to evaluate it.

The first point that I want clarified is this: Are there two kinds of agricultural engineers, i.e., (1) "agricultural" agricultural engineers and (2) "industrial" agricultural engineers? Apparently the proposed curriculum is set up for "industrial" agricultural engineers. If this is so, should it be recommended by the Society as a curriculum for agricultural engineers, or should it be recommended as a curriculum for one kind of agricultural engineer. If it is to be a curriculum for industrial agricultural engineers only, then my next point is not pertinent.

My second question is this: Is there such a dearth of engineering in agriculture that it is necessary to go to associated industries to get the material for a curriculum? Unless this dearth exists, it seems hard to justify a complete agricultural engineering curriculum based on the needs of associated industries. In my experience as an agricultural engineer, I have heard industrial men imply that they know more about many phases of farmers' needs than farmers do themselves. My own experience has seldom borne this out. In fact, I have sometimes been led to believe that one of the main reasons that some of these men are in industry, instead of running farms of their own, is that they don't know enough about farming to make a success of it.

I sometimes wonder whether, if we were completely fair and aboveboard, 75 per cent of us agricultural engineers would not leave off the word "agricultural" from our titles and just call ourselves engineers. I have heard a great deal of discussion within the Society of getting our profession recognized by other engineering groups as engineering. I have noticed very little concern over equal proficiency in scientific agriculture. There seems to be a sentiment that, if a man has been raised on a farm, he has most of the agricultural knowledge that he needs. Why does not the same sentiment apply to the other half of the title, namely, that a man who has worked with a pick and shovel on the state highway has most of the engineering knowledge that he needs? Is it possible that as a profession we know so little about the scientific aspects of farming that we have little appreciation of it? I have wondered if one of the main reasons why so many of us who were farm boys are now engineers is that we came from inefficient farms where the farm life was not sufficiently attractive to hold us. If this is true, we surely are not qualified from experience to have the term "agricultural" in our title, and we need a great deal of specialized training in scientific agriculture.

Frankly, I'm puzzled. What is an agricultural engineer? How many kinds of agricultural engineers are there? Does the study and report of this A.S.A.E. subcommittee constitute official recognition by the Society that there is so little engineering in agriculture our course of study should be based on the needs of associated industries? If so, should the graduate of such a course be called an agricultural engineer? I don't know the answers; I don't know what kind of a profession our Society represents, and I don't know in what direction our Society is going.

EARL L. ARNOLD

A Correction

The attention of readers of this journal is called to a typographical error on page 127 of AGRICULTURAL ENGINEERING for March, 1946; the cut designated Fig. 5 on that page is upside down. This occurs in the article, entitled "Bluegrass Terrace Outlet Channel Design", by Dwight D. Smith.

Equipment for Handling Partially Cured Hay

By C. N. Turner
MEMBER A.S.A.E.

THE production, harvesting, and storing of the hay crop is receiving a better share of the attention it has needed for many years. Hay is a major crop on many farms; it is grown on 83 per cent of our farms, and there are more acres of hay than of all other crops put together.

It became evident early in our work with barn hay driers that, if an easier method of harvesting hay could be developed, a curing method which would beat the weather and improve the overall quality of the crop, it would become widely accepted by farmers. During the past few years of critical labor and machinery shortages, farmers have been primarily interested in developments which would help them harvest the crop with the least man-hours and the least human effort. This has not always resulted in the best quality of hay. In fact, there are instances where custom machine harvesting was directly responsible for a serious loss in the quality of the hay crop. This was not due entirely to the system of harvesting, but to a combination of circumstances brought about by a shortage of labor and an abnormally poor hay-curing season.

With our trial installations of barn hay driers we were fortunate in being able to work with farmers who used most of the new and old methods of harvesting the partially cured hay. The majority used the standard side-delivery rake, hay loader, wagon, and hay fork. Three farmers used the buck rake and the wind stacker from the rear of the threshing machine. Five used the pickup field harvester and the hay chopper or blower at the barn. Six used the field pickup baler both with and without the conveyor handling equipment at the barn. Two of the farmers used the hay loader and truck with the regular hay chopper blower at the barn.

Hay Loader, Wagon, and Hay Fork. By far the greatest majority of our farmers will decide on the merits of the barn hay drier when used with the hay loader, wagon and hay fork for putting it into the mow. If the moisture content of the field-cured hay was 45 per cent or below, no difficulty was experienced with the rake, loader, or wagon but a few experienced breakage of their hay track, ropes, etc. Once the size of the hay fork load was learned by the operator, no more than normal breakage occurred. Several of the hay drier motors were used to operate both the hay hoist and the hay drier fan in order to speed up and save labor when unloading at the barn.

As to the problem of handling the heavier hay, records show that few if any additional man-hours are required over complete field curing with comparable equipment. This is due to the saving in time from more efficient use of labor and less handling of the hay in the field. For those who were accustomed to careful distribution of their field-cured hay in the mow, little additional labor was required in mowing away the partially cured hay for barn drying. While the records show few more man-hours required, there undoubtedly is more physical effort expended by the man who loads the wagon with partially cured hay and then mows it away in the barn. The cooler working conditions in the mow tend to offset the drudgery of this heavier handling to some extent.

If the quality of barn-cured hay is sufficient to warrant the additional cost of the barn-curing operation, mechanization of the harvesting operation will probably be warranted by the saving in labor and human effort.

Buck Rake and Wind Stacker. The transport buck rake constructed from a used automobile or motor truck and the old threshing machine wind stacker requires the least capital investment, the least labor, and is the cheapest method of putting hay on the drier when the fields are within ½ mile of the barn. The loading in the field is fast and easy, the travel to and from the barn is fast, the unloading at the barn is only a matter of seconds, and the distribution of the hay in the mow is practically eliminated. The only handling of the hay is pitching it into the wind stacker which is considerably easier than loading a wagon or truck and mowing the hay away when using the loader, wagon, and hay fork method.

With fields about ½ mile from the barn three men can keep a steady flow of hay going into the barn at the rate of 2 to 3 tons per hour. A boy on the buck rake often does the work of a man.

Field Harvester and Hay Chopper. The use of the field pickup chopper eliminates the labor of loading the hay in the field, reduces the trips to and from the field by taking large loads, but represents a problem of unloading into the hay chopper at the barn. To help solve this problem, two farmers used power-operated conveyor platforms in the bottoms of their wagons or trucks to unload the chopped hay onto the blower feed table. One of them used a small electric motor and the other the power take-off from the truck. The chopped hay can be uniformly distributed over the drier for uniform air flow, but most of the hay chopper blowers can be materially improved for this operation, because the chopped hay must not be walked on for best results.

The density of the chopped hay increases the power required by the fan over that required for long hay for any given depth. To help avoid too great a density, the moisture content of the chopped hay should not exceed 35 per cent for best results. While chopping the hay usually increases the capacity of the mow, with our present hay drier design this does not always hold true in high barns because the total depth through which the air can be forced is limited to about 14 ft.

Some types of barn frame construction will not permit the added weight above that encountered with 14 ft of chopped hay, some of which is only partially cured. If the barn timbers can carry additional weight, field-cured hay can always be placed on top of the mow-cured layers.

Since the chopping of hay lends itself so well to mechancial handling, many farmers would like to see the hay drier designed to cure a greater depth. Barn curing eliminates the two greatest objections to chopped hay, namely, dust and fire hazard. The heating which causes burning in the mow seems to be eliminated when partially field-cured hay is finished on the mow drier.

While chopped hay was very successfully cured on the driers this past year, there are certain precautions which seem to be necessary. The hay should contain about 35 per cent moisture and because of the greater density when placed in the mow, the operator *(Continued on page 165)*

This paper was presented at the barn hay-curing conference sponsored by the Committee on Hay Harvesting and Storage of the American Society of Agricultural Engineers at Lafayette, Ind., January, 1946.

C. N. TURNER is project leader, Farm Electrification Council of New York State.

Seven Years of Hay Drying Experience

By Harold Anderson

IN THE summer of 1939, three of my sons and I went to Knoxville to see the results of the work of the University of Tennessee and the Tennessee Valley Authority on drying hay in a barn. At that time we were using a field hay chopper, curing our hay in the field. It was only natural then that we attempted first to dry chopped partially cured hay in the barn. By the third cutting in the same year we had a barn equipped to blow air through the hay. Later we built a furnace and blew heated air through the hay. We installed a blower and distributing system to lay a fairly even bed of cut hay over the mow floor.

Our duct system varied from the system we had seen. We merely sealed the underside of the mow floor with plywood; then separated the boards on the mow floor about 1/8 in apart. The floor itself measured 120x36 ft. We divided it into two parts by putting a main duct across the center of the barn. The cross section of this duct is about 3x6.5 ft. We put in valves to stop the flow of air to either half of the barn. We used two 3-hp, 6-bladed, 3-ft diameter propeller-type fans, each with 18,000 cfm capacity at 3/8 in static pressure. To reduce the resistance of air flow into the cut hay, we placed two-by-fours on edge across the floor every 2 ft. On top of these two-by-fours we nailed 1x6-in boards. Thus for every 2 ft of floor space there was about 8 in of unpressed hay for the air to enter.

With as much as 6 or 7 ft of cut hay over this floor, the pressure would seldom rise over 3/8 in with 36,000 cfm of air flow.

With this system we dried hay with moisture contents up to 60 per cent, and obtained hay with high carotene content and otherwise excellent quality.

The main difficulty in producing quality hay with this system is mold. We had little if any difficulty with heating. To offset the difficulty of mold, we built a furnace with native stone, with inside dimensions about 7x7x7 ft. The flue through which we drew the heat and gas from the furnace was built on the ground and measured 3x7 ft. It made five 180-deg turns before entering the barn. Only a small portion of the total air blown through the barn was pulled from the furnace. Thus the air movement through the flue or stack was slow, and the sparks would drop out, particularly at the 180-deg turns.

This past summer we tried an entirely new system. We dried the hay and left it on the load until it was fed. We are now feeding this hay and it is of good quality.

We built 30 or 40 hay racks with open bottoms at a cost of about $10 each. We built six two-wheeled trailers, using heavy iron wheels and 6-in channel steel for the frames. We had built six 18-in diameter metal ducts about 4 1/2 ft long. We also built 30 or 40 wooden open ducts about 12 in square and 6 ft long.

In making the hay we partially cured it in the field. We used either a hay loader or a buck rake to load the hay on the trailers with open-top hay racks. On beginning the load we placed the metal spout in the center in a vertical position held there by a 1/2-in pin. When about half loaded, one of the open 6-ft wooden ducts was placed on top of the metal spout lengthwise of the load. Then the loading was continued until the rack was completely loaded. Our intention was to put on about 5 tons of partially cured hay.

These loads were then drawn by the tractor to a shed where we had constructed a stoker-fed furnace, the heat from which was blown with one of the 3-ft, six-bladed, 3-hp fans through an underground duct system. This duct system was made with concrete tile. It had six 18-in diameter outlets so placed that six loads could be run over the outlets. With airtight canvas socks, the outlets were connected with the metal spouts in the loads.

With the fan on overnight, blowing 110-deg air through the hay, the hay was dry in the morning.

The next operation was to move the loads ahead a few feet so they would be spotted over a hole in the ground so that we could remove the metal spouts from the loads of hay by pulling out the 1/2-in pins.

With the spouts removed, the loads were then placed on four 14-in wooden horses under an open holding shed, or out in the open where we covered them with canvases. The unloading of rack and load was accomplished by first dropping the front end of the two-wheeled trailer to the ground, then placing two of the horses under the rack at the rear. We then hoisted the front end of the load up in the air with two chain hoists attached to a large horse wide enough to completely straddle the trailer. The trailer was then removed and the load let down on two more of the horses, where it was left until wanted for feeding.

To load the hay rack and load back on the trailer, we reversed the process. The dry load of hay was then drawn to a feeding shed so constructed that it would hold one load of hay comfortably, with racks built on either side. The roof of the shed extended out to cover the cows as they ate the hay from the racks.

The hay produced by this system was of good quality and relished by the cows.

For a few loads of the third cutting this last year, we baled alfalfa hay of 30 to 35 per cent moisture and so stored it that air could circulate around each bale. Though we occasionally had some white mold, to our surprise the hay was of excellent quality, and even with the mold was relished by the cows.

We hope to try another system this coming summer. We do not believe any of the present systems we have tried or heard of are completely satisfactory.

You are all pretty well acquainted with the good points in the present systems and certainly there are many. Some of the undesirable points, however, are not so apt to be appreciated by anyone except the farmer doing the actual making of the hay.

To clarify what we might call undesirable points in the present systems, it mought be well to state what we consider requirements of an ideal system. They are follows:

1 To produce hay with maximum feeding value.

2 The process to be economical, and the cheaper the better.

3 The cost of getting the hay from the field to the cow, not counting the cost of the process, should be as low as possible.

4 The fire hazard must be reduced to a minimum.

None of the present barn-curing systems fully meet the above requirements, and neither does our present drying-in-the-load system.

This paper was presented at the barn hay-curing conference sponsored by the Committee on Hay Harvesting and Storage of the American Society of Agricultural Engineers at Lafayette, Ind., January, 1946.

HAROLD ANDERSON is a dairy farmer of Lucas County, Ohio.

Let us see wherein they fail. Without artificial heat it is impossible to prevent mold at times. This problem becomes aggravated (1) as moisture content of the hay to be cured rises, (2) when the hay is chopped before curing, and (3) when the humidity during the curing process is high. A combination of all three of these conditions makes mold a sure thing.

Artificial heat largely eliminates the possibility of mold. It is so relatively cheap and speeds up the process of curing so greatly that we believe it a prerequisite of any hay-curing system.

Let us now consider each of the ideal requirements. No. 1 is to produce hay with maximum feeding value. Though in any of the systems we have tried there is considerable improvement over field curing, these systems do not uniformly produce hay of maximum feeding value.

In practical application it is frequently impossible to be able to make hay at any given moisture content except at its moisture content when standing, say 75 per cent. With partial curing in the field you merely reduce the hazard of weather as it relates to quality of hay produced; you do not eliminate it.

Let us consider No. 2 — the costliness of the system. When you are handling surplus water in hay, you are handling additional tonnage, which is expensive. Also a drying system in every barn makes quite a sizable investment, considering the storage capacity of the barn.

No. 3 requirement is field costs and costs of removing from storage to feeding. Again the additional tonnage of moisture in the hay adds to the labor and costs. The present common system of feeding either field-cured or barn-cured hay from a barn needs an overhauling, as it is the most laborious feeding operation on the farm. Our system of storing on the load has merit here.

As for No. 4 requirement, reducing fire hazard, I believe any of the curing systems do that, but I feel the principle of storing hay in the same building where it is fed makes an unnecessary fire hazard. Baling is an aid here.

What then would be the ideal hay curing system? We plan to begin work this summer on what we think it might be.

WILL ATTEMPT TO DRY HAY IN THE FIELD IMMEDIATELY AFTER IT HAS BEEN CUT

It is our plan to attempt to dry hay in the field immediately after it is cut. Then from the drier to the baler for easy handling and economical storing. To accomplish this it is our thought to use some machine which crushes the stems of the hay as cut by passing the cut hay through rollers. While the hay is being crushed we intend blasting it with hot air, this heat to be produced by an oil burner. Following this blast of hot air, the hay would be carried between two open aprons sufficiently long to allow more warm air to pass through it until it is dry enough to bale. The dried hay would pass to a baler.

We believe $5000 should be a fair estimate for the cost of this equipment. It is not at all difficult to spend $1000 on a barn hay-curing setup. A field drier would easily cure and bale the hay for five such farms; indeed, for many more. The fuel cost would be considerably higher, but the saving in labor and improvement in quality should amply care for this. Fuel costs on commercial hay driers run from $1 to $2 per ton. The added feeding value would offset any such costs.

The saving in labor from field to cow should be maximum as there would be no handling of excess moisture and the hay would be in bales easy to handle.

Hay so cured in the field and baled should enable the farmer to eliminate fires due to hay stored in the barn.

Handling Partially Cured Hay

(Continued from page 163)

should be careful about loading the system too deep when the hay is near the maximum recommended moisture content, and the chopped hay must not be walked on when it is damp. Some of the field choppers have not handled the partially cured hay as successfully as others.

Field Pickup Baler and Conveyor. In the opinion of many authorities, the field pickup baler is better adapted to the large farm than to the small one. It has been used most economically on large farms where fields are far from the barn storage, where hay must be stored in one barn and moved to another barn for winter feeding, where hay is to be offered for sale, and where the machine can be used to pick up and bale the combined straw. A large crew is usually required; otherwise the baled hay is left in the field subject to considerable loss from sun bleaching, heating inside the bale, dew and rain. It is a rare occasion when the custom-baling operation can be used successfully to put partially cured hay on the natural air drier at the most satisfactory moisture content. Many requests have come to us from farmers who want to use a hay drier to keep the hay from heating in the bale after they have been forced to have it baled just a little too wet for safe storage. The hay drier may serve a useful purpose for this purpose alone in connection with the baled-hay method of harvesting.

A CONVEYOR IS USUALLY REQUIRED FOR PLACING THE HEAVY BALES ON THE DRIER FOR CURING

A conveyor is usually required to assist in storing the heavy bales on the drier. In a few instances, the bales have been piled outside the barn and cured by forcing air inside the pile. The fan unit is portable and is moved from one pile to another. This has proved to help in an emergency, but otherwise seems impractical in our state due to the extra handling.

The density of the baled hay is approximately the same as that of chopped hay and thus requires more power to force the air through the pile or layer than does long hay. Few pickup baling machines make a satisfactory loose bale and most of them are not built to handle hay containing over 25 per cent moisture. The slatted floor type of drier seems to be the system best adapted to drying baled hay. A depth of 7 to 8 ft seems to be satisfactory when the air delivery of the fan is at least 16 cfm per sq ft of mow floor against 1 in static pressure. The total depth of bales on the system should not exceed 10 to 12 ft with present design of the system.

Hay Loader, Truck and Hay Chopper. This method has the disadvantage of having to load the truck from the hay loader and unload by hand pitching into the hay chopper at the barn. Otherwise, it is similar to the field harvester and hay chopper combination. Care must be used in setting up the chopper and distribution pipe to avoid plugging and to get good distribution of the hay over the drier. This method does not appear to have any advantage over the use of a wind stacker at the barn, except that more tons can be stored in a mow and the chopped hay handles easier from the mow to the feed alley.

Of the 23 farmers owning hay driers, who replied to our survey questionnaire, all but two stated that their present system was worth the extra cost and labor.

In conclusion, partially cured hay has been harvested and stored on the 50 installations of barn hay driers in New York state using all of the most popular haying machinery with reasonably good success. If there was any one mistake made, it was that of placing too much hay on the driers with too high a moisture content.

Operation of Hay Driers in Virginia

By Ralph E. McKnight
FELLOW A.S.A.E.

DURING the 1945 haying season 247 driers were in operation on Virginia farms and of this number 122 were installed in 1945. This method of curing hay is gaining widespread approval over the state. A number of requests have already been received by the extension agricultural engineers of Virginia Polytechnic Institute for technical assistance in the selection of equipment and design of systems for installation during the 1946 season. Provided equipment and lumber are generally available for this purpose, it is conservatively anticipated that over 200 installations will be made in the state during 1946.

This work was first started in southwest Virginia in 1939. Most of the farm land in this section of the state varies in elevation from 2000 to 2200 ft. Rainfall is frequent, relative humidity is high, and the temperature is low as compared to that of the surrounding areas. These conditions are not favorable for harvesting hay by any known methods, including the use of the hay drier. Regardless of this combination of unfavorable factors, barn hay drying is fast becoming an accepted practice in Virginia. Duct design has been improved and the present systems are more efficient than the first ones used.

The first type duct system used was rather inefficient. It had a high system resistance and very uneven pressure distribution throughout the system. Based on recommendations of the Tennessee Valley Authority, the first systems were designed for approximately 10 cu ft of air per minute per square foot of floor space. This was increased to an average of 16 cfm per sq ft of floor area during 1945.

In the development of hay drying in this state various methods of handling hay and operating driers have been tried. After six years' experience this procedure has become somewhat standardized.

In the beginning hay was cut in the usual manner, was partially cured in the field to a moisture content of approximately 45 per cent, and then was placed on the drier to complete the curing process. This was done with whatever equipment the operator had available. In many instances dump rakes were used and the hay was loaded on the wagon by hand. Many barns were equipped with harpoon forks for unloading from wagons. Farmers and extension agricultural engineers soon learned that some commonly used haying practices and equipment were not satisfactory for handling partially cured hay. The following recommendations were accordingly made for operation of hay driers during the 1945 season:

1 *Stage of maturity of crop.* Cut alfalfa one-tenth to one-quarter full-bloom stage. Check with local county agent for best stage of maturity for cutting other hay crops.

2 *Time of day to cut.* Most successful operators follow one of two procedures in cutting: (a) Begin cutting in the morning as soon as most of the dew is off, cutting no more than can be put in the barn that afternoon, or (b) cut late enough in the afternoon so that no wilting occurs that day and leave in the swath overnight, cutting no more than can be put in the barn the following afternoon.

3 *How long to leave hay in field.* Allow hay to wilt in the field up to the point where the maximum amount of moisture is removed, but not dry enough for leaves to shatter in handling. Wilted hay should not be exposed to rain or dew. On a good hay-curing day, two hours in the swath and two hours in the windrow is long enough.

4 *Placing hay on the drier.* The hay must be distributed evenly and packed uniformly over the duct system *as it is unloaded into the mow.* Best results are obtained where not less than 4 ft nor more than 8 ft of hay is placed on the drier for the first loading. Additional loadings of not exceeding 6 ft each may be placed on the first and cured. Not more than 15 ft in all should be placed over the system.

5 *Operating the fan.* Start the fan as soon as some hay has been placed on the duct system (at least within 2 hrs after the first hay has been unloaded) and operate it at all times when the outside air is such that it will remove moisture from the hay. The time clock control should be set as follows: On 8:00 a.m.; off 9:00 p.m.; on 12:00 m; off 1:00 a.m.; on 4:00 a.m.; off 5:00 a.m. On rainy days operate fan 1 hr to 3-hr intervals. Keep all mow doors and roof ventilators open during the curing period to remove moist air from over the hay.

6 *How to tell when hay is cured.* The top foot of hay will be the last to dry. When this appears to be dry enough, stop the fan and leave off over night. The next morning, start the fan and immediately walk over the hay to see if any warm air is coming out of it. If so, operate the fan two more days and repeat this check.

The 1945 season was unusually wet in Virginia. It was found that 2 hr in the swath and 2 hr in the windrow was not long enough to lower the moisture content of the hay to 45 per cent, which is the recommended moisture content for placing the hay in the barn. When the ground was damp from previous rain and the dew unusually heavy, it was found that 3 hr in swath and 3 to 4 hr in the windrow were sometimes necessary. Turning the windrow once with a side-delivery rake hastened drying materially. Some farmers followed this practice when weather conditions were unfavorable.

For satisfactory handling of damp long hay the use of side-delivery rakes, hay loaders, swing-type grapple hay forks and hay hoists eliminate much of the hard work. The problem of proper distribution of hay over the duct system remains to be solved in this state. The practice of using a chopper and blower has not been tried in Virginia on enough farms for definite conclusions to be made. Present indications are that this method deserves further consideration, especially if the length of cut could be increased. Some farmers object to feeding finely chopped hay.

Recently a letter was written to every hay drier owner in the state asking what he thought of this method of curing hay and if he would recommend it to other farmers. Only one farmer reported unfavorable results. The following quotations were taken from some of the replies to this questionnaire and are typical of the answers:

"Our production from 32 cows and 8 3-yr-old heifers in 1945 was 416974 lb of milk of 3.8 per cent butter fat. Our producttion from the same number of cows for 1944 was 348422 lb of milk. All cows were milked twice a day and were fed 1 lb of 18 per cent dairy feed for each 5 lb of milk. Only four of these cows produced under 400 lb of butter fat. If our heifers *(Continued on page 168)*

This paper was presented at the barn hay-curing conference sponsored by the Committee on Hay Harvesting and Storage of the American Society of Agricultural Engineers at Lafayette, Ind., January, 1946.

RALPH E. MCNIGHT is assistant extension agricultural engineer, Virginia Agricultural Extension Service.

Curing Hay in the Stack with Forced Air

By J. H. Ramser and E. W. Lehmann
FELLOW A.S.A.E.

TESTS were made in England[1] during the early 1920's in which air was blown through hay stacked over a frame that formed a cavity within a round stack. Heated and unheated air was used in these tests, and it was reported that both produced a good quality hay; however, the use of heated air gave more satisfactory results for the humid conditions under which the tests were made.

In 1927, Prof. Wm. Aitkenhead of Purdue University[2] reported the results of stack curing with forced heated air. Although a good quality hay was produced, there was some question as to whether the added cost was justified. In his early experiments with hay curing by forced air, J. W. Weaver of the Tennessee Valley Authority[3] used a small gasoline engine to drive a fan for forcing air through a stack of hay. In this test, hay with 65 per cent moisture content was used, and it was reported that with this high moisture content the results were not satisfactory.

With the improved techniques and generally good results being secured in barn hay curing with forced air using electric power, it was thought possible and also desirable to develop a method of obtaining high-quality hay where barn space and electric power were not available. Such a method of hay curing would be desirable when the hay was to be disposed of without storing it. Accordingly, a method of stack curing with somewhat different technique than had previously been used was planned and put into effect by agricultural engineers at the University of Illinois. The essential differences of this plan from former methods of stack drying are the type of duct provided, the use of a specially designed portable blower unit, and the use of a porous fiberglas tarpaulin to cover the upper part of the stack for protection against rain and to equalize the air flow through the hay.

Due to the limited amount of hay that was available for the tests, it was decided to use stacks of about ten tons in size. The duct was designed for this size stack, although it was believed that the capacity of the fan was sufficient for a greater amount of hay.

The main duct (Fig. 1) was built in the form of an A frame 14 ft long. The framework was built of 2x4's two feet apart, covered with 1x4-in strips one foot apart. The over-all cross-sectional dimensions of the A frame were 3 ft wide at the bottom and 1 ft at the top with a vertical height of 5 ft. This gave a free area for air passage of approximately 6½ sq ft. From the fan and motor enclosure to the A frame, a tight connecting duct 8 ft long with framing inside was used. To ventilate the hay over this

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This paper was prepared expressly for AGRICULTURAL ENGINEERING, and reports results of tests conducted by the agricultural engineering department of the University of Illinois.

J. H. RAMSER and E. W. LEHMANN are, respectively, associate in agricultural engineering and head, agricultural engineering department, University of Illinois.

[1] "Preliminary Report of an Investigation Into the Artificial Drying of Crops in the Stack." Institute of Agricultural Engineering, University of Oxford, Oxford, England.

[2] "Some Stack and Grain Drying Results," William Aitkenhead. AGRICULTURAL ENGINEERING, vol. 8, no. 8, August, 1927.

[3] "The Development of a Low-Cost Hay Drier," J. W. Weaver, Jr. AGRICULTURAL ENGINEERING, vol. 18, no. 1, January, 1937.

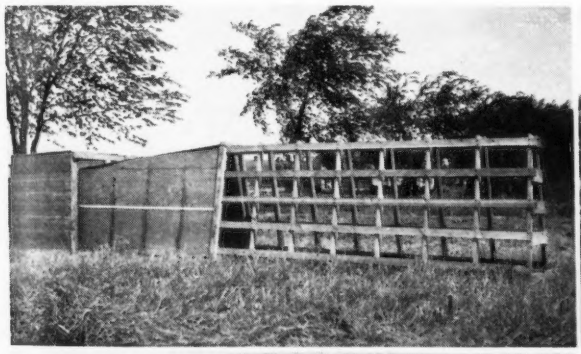

Fig. 1 *(Upper left)* This view shows the main duct used in the tests conducted by agricultural engineers at the University of Illinois on curing hay in the stack • Fig. 2 *(Upper right)* A view of the engine, fan, and enclosure • Fig. 3 *(Lower left)* In this picture the hay is being stacked over the duct • Fig. 4 *(Lower right)* The finished stack with the fiberglas tarpaulin cover

connecting duct, slots 1½ in wide extending halfway from the A frame to the motor enclosure were left on each side at the bottom and in the center of the top.

Where a number of stacks are to be cured with one unit, it would be desirable to make use of the connecting duct for each without removing the hay. This could be accomplished by making the tight duct of uniform height and nailed to the A frame from within the duct. In this way, the tight duct could be disconnected from the A frame and pulled from under the hay with a tractor. It would not be practical to withdraw the A frame from under the stack so that additional sections of this part would be needed if a number of stacks are to be cured before baling.

A 15-hp internal-combustion engine, such as is used on a small tractor, was used and was directly connected to an 8-blade propeller-type fan. The fan and engine unit was enclosed by a 5 by 5-ft structure (Fig. 2) so that all the air to the fan passed over the engine. The heat given off by the engine raised the temperature of the circulating air approximately 5 F (degrees Fahrenheit) in these tests, thus increasing the drying effect.

Sisalkraft paper was placed under the stack to prevent damage by moisture from the ground. The base of the stack extended 8 ft in all directions from the A frame, making the base dimensions of the stack 19 by 30 ft. The sides of the stack were sloped about the same as the sides of the A frame, and the stack extended 8 ft above the top of the frame, making a total height of 13 feet and approximately 13 ft across the top. The hay was taken from the windrow and placed on the stack by a stacker as shown in Fig. 3.

The top of the stack and the sides about 5 ft from the top were covered with the fiberglas tarpaulin. One of the advantages of the fiberglas tarpaulin, in addition to giving protection against rain, is that being porous, even though wet, it permitted passage of some air. Sufficient tests were not made to check the use of the tarpaulin on the effect of air movement, that is, comparing results when only the top was covered, with no cover, and with the top and sides partly covered. Fig. 4 shows the completed stack with the tarpaulin in place as used in these tests.

The speed of the engine was checked in the laboratory at different throttle notches. In daytime drying, it was operated at a speed that required about one gallon of gasoline per hour and at an approximate speed of 1300 rpm which produced a greater air flow than was anticipated when the air duct was designed.

In drying long alfalfa, a static pressure of 1 in of water was maintained. The resulting air pressures were 1.2 and 1.6 in of water, respectively, when drying timothy and soybean hay. The air flow at these pressures and 1300 rpm of the fan, according to information furnished by the manufacturer, were 17,000, 16,000 and 13,000 cfm (cubic feet per minute), respectively, for alfalfa, timothy, and soybean hay. With a cross-sectional area of duct of 6½ sq ft, these air flows caused maximum velocities of 2,610, 2,460 and 2,000 fpm (feet per minute) for alfalfa, timothy, and soybean hay, respectively. The velocities are high for a duct of this construction; and if these quantities of air are to be used, it is suggested that the free area of the main duct be increased to reduce the air velocity to about 1500 fpm.

During the night hours, the engine was operated at a speed that used about one-half gallon of gasoline per hour. The blower was operated most of the night, preventing heating and accomplishing some drying. With the equipment used, it was necessary to add gasoline three times each day. These fillings were usually made at 8 a.m., 1 p.m., and 5 p.m., although the noontime filling could be delayed two hours if necessary. When curing was almost completed, the fan was operated only during the daytime for the remainder of the drying.

Table 1 gives the data collected on three tests during the season of 1945. Due to the shortage of labor, it was not possible to stack the hay at just the moisture content desired. The tests were planned to put the hay in the stack with an initial moisture of about 45 per cent. Due to work delays, some of the hay was put in the stack at a much lower moisture content than this. However, none of it was dry enough for ordinary barn srorage or baling when stacked, and there was no appreciable loss of leaves.

TABLE 1.

Date tects started	Kind of hay	Average initial moisture content, per cent	Average final moisture content, per cent	Amount of dry hay, tons	Days fan operated	Actual fan operation, hr	Average air volume high speed cfm	Gasoline per ton dry hay, gallons	Average relative humidity when fan operated, per cent		Average static pressure high speed, in	Volume of air per ton dry hay, cfm	Maximum air velocity, fpm
									High speed	Low speed			
June 20	Long alfalfa	36.6	15.95	9.8	7	89.5	17,000	9.45	51.1	77.8	1.	1735	2610
July 7	Long timothy	26.9	12.0	10.9	5	54.0	16,000	3.87	57.1	86.8	1.2	1465	2460
Aug 31	Long soybean	37.8	12.25	10.	11	124.	13,000	11.6	58.0	69.6	1.6	1300	2000

Since the outer surface dried last, it was only necessary to examine the outside layer to determine when curing was complete. The hay in all three tests maintained its color quite well and was only slightly off color after curing than when stacked. In all cases, the cured hay was baled out of the stack as soon as possible after curing was finished.

Hay Driers in Virginia

(Continued from page 166)

production were adjusted to mature equivalent, we estimate that our average production would have been 426 lb of butter fat per cow against 356 lb in 1944."—D. Terpstra.

"So far in feeding the hay from the drier it is of better quality, was stored in less space, cows like it better than field-cured hay, also I am getting better production." — J H. Neel.

"I cannot express to you just how much I like my hay drier, although I have used it only one season and have now only been feeding out of the mow about a month. Most of my hay was clover with some timothy and lespedeza. The clover hay is the best clover I have ever cured. I put it in green and now I wish you could see it. There is not one bit of dust about it. I would not want to be without the drier, and I think we will soon have them in all our barns. When we could not think of putting hay in the other barns, we would haul and put it on the drier."—Harvey Cornwell.

The best evidence we have of the value of hay driers to farmers is the fact that after using a drier for one year all of the operators having additional barns have installed driers in the remainder of their barns. These farmers were good business men and were convinced that hay driers were a paying proposition or they would not have installed additional ones.

Resistance of Hay to Air Flow and Its Relation to Design of Barn Hay-Curing Equipment

By Claude K. Shedd
FELLOW A.S.A.E.

TWO lots of hay were tested for resistance to air flow at the agricultural engineering laboratory at Iowa State College in June and August, 1945. The tests were made in a plywood bin about 7 ft square with perforated false floor, the same bin, blower, and measuring instruments previously described in an article, entitled "Resistance of Ear Corn to Air Flow", published in AGRICULTURAL ENGINEERING for January, 1945, except that in the hay tests an inclined tube water manometer was used for measuring static pressures in the plenum chamber under the false floor.

The first lot of hay was first-cutting brome-alfalfa mixed hay. Proportions were not determined, but from observation it was estimated to be about three-fourths brome and one-fourth alfalfa. The bin was filled on June 18, 1945, to a depth of 10 ft with 2310 lb of hay testing 30 per cent moisture. Calculated to 20 per cent moisture, the weight was 2020 lb which is 37.9 lb per sq ft of floor. The hay was spread evenly and tramped as the bin was filled, using care to pack the hay against the walls and into the corners of the bin.

The second lot of hay was second-cutting alfalfa hay containing less than 2 per cent each of red clover and grass. The bin was filled with this lot of hay on August 13, 1945, to a depth of 8 ft, 3 in, with 2540 lb of hay containing 27.5 per cent moisture. The weight calculated to 20 per cent moisture was 2300 lb, or 43 lb per sq ft of floor.

Each lot was tested at three rates of air flow — 10, 15 and 20 cfm per sq ft of floor. The results are recorded in Table 1.

Data recorded in Table 1 are plotted to logarithmic scale in Chart 1. The advantage in using logarithmic scale is that, if the data fall on straight lines, it shows that the relation between air flow and pressure may be expressed by a formula of the form:

$$Q = aP^b$$

where Q = air flow in cfm per sq ft of floor
P = static pressure or pressure drop passing through the hay in inches water column
a and b are constants for any given depth and condition of hay.

TABLE 1. RESISTANCE OF HAY TO AIR FLOW

Date (1945)	Depth of hay*	Q	P
Brome-alfalfa hay, filled to depth of 10 ft, June 18, 1945			
June 20	8 ft	10.1	0.13
		14.9	0.22
		20.0	0.34
June 21	7½ ft	10.1	0.13
		14.9	0.23
		19.9	0.35
June 22	7¼ ft	10.3	0.14
		15.5	0.25
		19.9	0.37
June 28	7 ft	10.4	0.17
		15.6	0.32
		19.7	0.45
Alfalfa hay, filled to depth of 8 ft 3 in, Aug. 13, 1945			
Aug. 14	8 ft 2 in	10.3	0.20
		15.1	0.32
		19.8	0.46
Aug. 22	7 ft 9 in	10.1	0.21
		15.1	0.36
		19.4	0.48

*Depth to which hay had settled

This paper was presented at the barn hay-curing conference sponsored by the Committee on Hay Harvesting and Storage of the American Society of Agricultural Engineers at Lafayette, Ind., January, 1946. Approved as Journal Paper No. J-1348 (Project No. 922), Iowa Agricultural Experiment Station.

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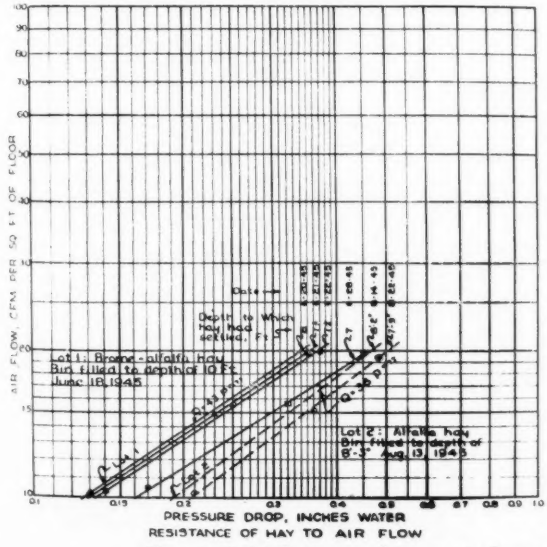
AIR FLOW, CFM PER SQ FT OF FLOOR
Date →
Depth to which hay had settled, Ft. In.
Lot 1: Brome-alfalfa hay Bin filled to depth of 10 Ft June 18, 1945
Lot 2: Alfalfa hay Bin filled to depth of 8'-3" Aug. 13, 1945
PRESSURE DROP, INCHES WATER
RESISTANCE OF HAY TO AIR FLOW

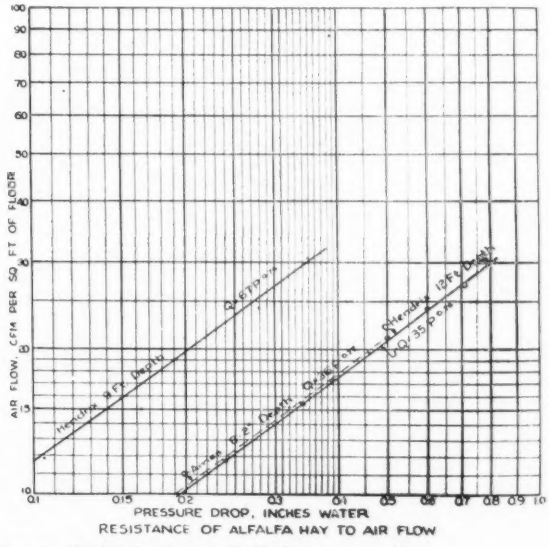

Chart 1 *(Left)* Resistance of hay to air flow • Chart 2 *(Right)* Resistance of alfalfa hay to air flow

The value of a may be obtained graphically from the chart. It is the value of Q when $P = 1$. The exponent b is the slope of the data line which also may be measured on the chart. Values of botn a and b can be determined more accurately by mathematical calculation. The formula with numerical values for the first test of each lot of hay is shown on Chart 1.

Data shown in Chart 1 indicate a small increase in the pressure required to cause a given rate of air flow as the hay dried and settled.

The static pressure required to cause a given rate of air flow was greater with alfalfa than with brome-alfalfa hay. The brome-alfalfa was coarser and did not pack as tightly in the bin.

A comparison of results of the tests at Ames with those obtained by Hendrix[1] is of interest. For this purpose, Hendrix' data for 9-ft and 12-ft depths have been taken from Fig. 2 in the reference just cited and plotted to logarithmic scale together with results of the first test of alfalfa at Ames in Chart 2. Hendrix states that, when the 12 ft of hay was cured, the depth had settled to about 8½ ft and the density at that time was about 5 lb per cu ft. This amounts to 42.5 lb of hay per sq ft of floor which is nearly the same as the 43.0 lb per sq ft of floor contained in the bin at Ames with an initial depth of 8 ft, 3 in. Comparison on a basis of weight of cured hay per square foot of floor brings the two sets of data into close agreement and suggests that the weight of cured hay per square foot of floor may be a better figure than depth of hay for estimating air flow. The slopes of the three data lines in Chart 2 are about the same, which indicates an approximately uniform relationship between air flow and pressure.

It will be noted from Charts 1 and 2 that the exponent of P in the formula $Q = aP^b$ varied from 0.71 to 0.77. This is not in agreement with the formula that has been found applicable to flow of air in a duct system which is based on the law of a falling body, $V = \sqrt{2gh}$. In tests of air flow through hay, velocity was found to vary not as $P^{0.50}$ but about as $P^{0.75}$. A question may be raised about this result because it does not agree with commonly accepted theory. However, the value $P^{0.75}$ was obtained by two investigators working independently and it is thought to be substantially correct for good quality alfalfa hay.

It is of interest to compare this result with data obtained in tests of resistance of grains to air flow. For this purpose, reference is made to articles published in AGRICULTURAL ENGINEERING for November, 1943; April, 1944, and January, 1945, in which the exponents of P in the formula $Q = aP^b$ were reported to be about as follows: Ear corn, 0.50; shelled corn, 0.68; grain sorghum, 0.88; and oats, 0.88. All of these results indicate that air flow through porous materials may not follow the law that velocity varies as the square root of pressure head, but that the velocity may vary as some other power of pressure which can be determined only by experiment. This is evident between different kinds of hay as shown by data presented in Table 1.

Relation to Barn Hay Drier Design. Some barn hay-curing installations have been designed for delivery of 10 cfm per sq ft of floor against static pressure of ¾-in water column. This rate of air flow has been found insufficient in some cases to cure the hay without some spoilage, and it has been suggested that air flow of 15 cfm per sq ft of floor may be the remedy. The higher rate of air flow results in a large increase in static pressure and a still larger increase in power requirement. According to the results reported above, increasing air flow from 10 to 15 cfm per sq ft of floor would cause static pressure to increase by a factor $(15/10)^{1/0.75}$, or 1.8, and the power requirement to increase by a factor (1.5×1.8), or 2.7. This calculation applies only to resistance within the hay. Power required to overcome resistance between the fan and the hay would be expected to increase as the cube of the rate of flow.

Since barn hay-curing installations designed for air flow of 10 cfm per sq ft of floor require, in most cases, 3 hp or more to drive the fan, it is obvious that, without some improvements in design, the power requirement for air flow of 15 cfm per sq ft of floor cannot be kept within a limit of 5 hp except in barns of smaller than usual size. It is important to stay within this limit since few farms have electrical transformer capacity larger than 5 hp.

It is significant that in the tests reported above the greatest static pressure observed for air flow of 10 cfm per sq ft of floor through 8 ft of alfalfa hay was about 0.2-in water column. If 0.75-in pressure was used as a basis of design, then less than one-third of the designed horsepower was used in overcoming resistance of the hay to air flow (assuming 8 ft depth); more than two-thirds was for factor of safety and to overcome losses between the fan and haymow floor. This indicates a good margin for possible improvements in design and a possibility that pressures against which the fans operate may be reduced enough to make an increase of air flow to 15 cfm per sq ft of floor practicable.

Assuming that ducts are of adequate size, the most important causes of loss of head between fan and haymow floor are (1) air leakage, (2) turbulent air flow at high velocities which increases resistance to flow and tends to convert kinetic energy to heat, and (3) excessive friction where the air discharges from the ducts into the hay. There is some evidence that this last point may be important. In a test of a hay drier in one of the Iowa State College barns, a pressure of 0.6 in was observed at the ends of lateral ducts and only 0.2 in at the haymow floor midway between ducts. That is, the pressure drop in entering the hay was twice as much as the pressure drop in passing through about 6 ft of brome-alfalfa hay. A substantial saving would be effected by use of a false floor or by use of ducts with large openings into the hay.

It seems obvious that improvements in hay drier design to reduce the pressures against which fans must operate are highly desirable, especially if rates of air flow greater than 10 cfm per sq ft of floor are to be used; and apparently there are good opportunities for making such improvements if research projects are directed toward that end.

[1] Hendrix, A. J. Resistance of hay to air flow. Agr. Engr., September, 1945.

Engineering's Economic Environment

(Continued from page 157)

At the risk of oversimplifying a complex problem, we would like to see the thought pursued along the line of some further questions. Would it be valid to say that, in an economy of abundance, economic velocity or material prosperity is limited by capacity to consume rather than by capacity to produce? Would it follow that, within the area of this economy, real wealth is some capitalization of effective capacity to consume? And, further, could it be said that in this abundance economy the ideal division of total annual or cumulative income would be one in which the portion spent for consumer goods would be enough to absorb such goods up to total production capacity, as added to by the portion of income saved and added to capital? Could some practical extensions of the economic laws of supply and demand and diminishing returns guide an intelligent, free-enterprise, abundance economy to action which would minimize periodic depression? *(Continued on page 178)*

Rotary Soil Tillage

By C. W. Kelsey
MEMBER A.S.A.E.

AS EARLY as 1850 to 1860 patents were taken out covering rotary plows. All of these early designs proved unsuccessful. Not until 1910, when a revolutionary new principle was invented by Von Meyenburg of Switzerland, did the rotary principle of soil preparation appear as a practical answer to the rotary idea. In this paper, wherever the term "rotary tillage" is used, it refers to the method originated by Von Meyenburg (1) of mounting comparatively small soil-cutting tools on springs and revolving them through the soil at relatively high speed, with each tool displacing only a small amount of soil at each revolution, or (2) of making the cutting tool itself a spring or otherwise resiliently mounting it.

Before a meeting of the American Society of Agricultural Engineers at Chicago, in December, 1933, I presented a paper on the efficiency of rotary tillage, at which time I had had three years' experience with the rotary method of soil preparation. Since then I have devoted my time to this development. In this latter period, thousands of Rototillers have been sold and put in use throughout the United States, in sizes varying from 1½ hp with an 8-in cut to 110 hp with a 72-in cut. These machines have been operating under every conceivable condition and have been used for light cultivating work under ideal conditions to scarifying old highways.

In addition to the information that we have gathered here in the United States, we have continually benefited from our association with the original Swiss inventors and manufacturers.

Prior to the introduction of this new method of soil preparation, the operations of plowing, disking, harrowing, dragging were in general use in power farming, and small hand operations included spading, hoeing, forking, and raking. The word "tilling" was not used in conjunction with the use of power, in soil preparation. The word "tiller" was more generally used in referring to the steering of a boat than in any other way. Also, "tillers" are certain well-known types of roots, while the "till" was the popular place to keep money until replaced by the cash register.

A power-driven rotary soil-tilling device to be completely successful must work in any type of ground and prepare it for planting in a single operation. Eventually it must do in this single operation, under the most difficult conditions, a better job than can be accomplished in the three operations of plowing, disking and harrowing. Ground conditions vary from hard clay with imbedded stones and other trash to loose, clean, sandy loam, volcanic ash, and muck. In any of these conditions, there may be a cover crop from a few inches to several feet high. The eventual machine must be able to shred this cover crop and mix it throughout the soil. It must be able to go into a field of standing corn and chop it up completely and bury every particle of cornstalk and leave a clean seedbed ready for planting. It must be able to go into the heaviest kind of straw manure and mix it thoroughly and evenly throughout the seedbed. It must be able to do any of these things at one passage over the ground, at any season of the year when the ground is not frozen or too wet. Most of these requirements have already been met.

The machine must also permit the proper placement of fertilizer, the preparation of the seedbed, and the planting, all in one operation with only one operator. This we have accomplished where conditions are reasonably good. In addition the machine must be able to do a thorough job of weed killing, mulch cultivating in single or multiple rows, and do all other jobs any normal tractor will do efficiently and easily.

Primarily the grower wants a machine that, with the least effort and expense, will produce the most profitable crops. What is needed in Maine in the way of soil preparation and cultivation will vary from what the grower in Florida wants. The requirements of the grower in a dry area are different from those of one in a wet area. It must be remembered that there are many conditions under which even an ideal seedbed will not produce a satisfactory crop. Extreme wet and boggy conditions, drought, dust storms, and grasshoppers are a few examples. However, agronomists are, I believe, generally satisfied that a properly prepared seedbed will always outproduce a poor seedbed under adverse conditions, providing the conditions are such as to permit growth.

Fig. 1 This picture shows the comparison between a seedbed prepared by the Rototiller and the condition of ground plowed with the conventional moldboard plow

The original Swiss rotary tillage machines built around the Von Meyenburg patents were small, but almost immediately the possibility of large-acreage machines loomed important and rotary tillers having a 6 and 7-ft cut were developed in Europe. Generally speaking these machines failed as they were single-purpose machines built only to prepare a seedbed. After this one job was done, the machine lay idle tying up an investment of several thousand dollars. Thus gen-

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

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erally they proved to be an economic failure in spite of the better soil preparation and resulting better crops. Accordingly European efforts were directed toward perfecting the smaller machines. The American company with which I am associated first began to introduce the European-made machines into the United States in 1930. We started at once to develop large-acreage machines and, parallel with this, to perfect the smaller machines for American growing conditions which vary from European conditions.

Our first engineering was simply keeping track of the European-built machines we had imported and sold. We noted the difficulties users encountered. Most of the first machines sold went to underglass growers and nurserymen. The conditions under which they operated were favorable; consequently we became overenthusiastic. This lasted only for a short period until we sold rotary tillage machines to do work in difficult, stony or hard ground. Then our troubles started. Spring and tine breakages were frequent and costly in both time and money for the owners; gears broke, and bearings let go. In studying this problem, we learned that the blow seldom broke a spring or tine unless the revolving speed was excessive. The principal cause of breakage was rebound. Having established this fact, it did not take long to develop a simple, reliable rebound check, or shock absorber, and at the same time we changed from high-carbon steel to electric-furnace chrome-vanadium steel. The proper temper is still a question, that is, whether to have the tools and springs under extra high stress break or bend. There are good arguments both ways. Today we temper to a Rockwell hardness of 40-42 on the C scale and are more apt to have bending than breaking.

Breakage is generally progressive. An extra strain or extreme shock will start a fracture which will grow progressively. The final failure nearly always occurs when working under light, easy conditions. The better steel and shock absorber quadrupled the life of springs.

With these improvements, tines more generally wore out than broke. This wearing out of tines became our next problem and we found that, by stelliting one of the cutting edges and leaving the other soft, a sharp tine always resulted from normal abrasion. Stelliting, however, required retempering, resulting in a costly tine. In highly abrasive conditions, this additional cost is justified by the longer life and time saved in changing. The shape of the cutting tools and the pick action of the tine, we found, were important. A properly shaped tine would consume far less power and produce equal or better results. This led to a long series of experiments, from hammer-mill action at high speed to low-speed action of a simple pick.

Our first problem was to determine with reasonable accuracy the best shapes of cutting tools. This necessitated a simple and accurate method of comparison of soil hardness.

In our work with Prof. A. A. Stone, then agricultural engineer at the New York State Institute of Applied Agriculture, a penetrometer or soil-hardness tester was developed. This extremely simple instrument permitted a series of surface readings and then, by scraping off the top one inch of soil, a series of subsurface readings down to any desired depth. Data on moisture content was taken by electrical resistance, comparative readings being made at different depths. This method is not as accurate as we would like because the salts or acidity in the soil will cause variations in the readings as compared with pure water. However, it does give accurate comparisions under the same conditions.

The European manufacturers of our machine had conducted a long series of tests on the shapes of cutting tools. As a result, four principal shapes for different purposes had

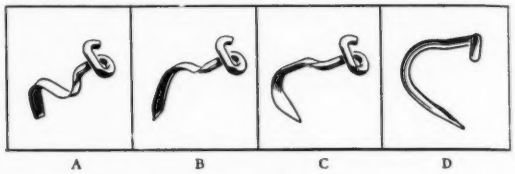

Fig. 2 The four principal shapes of cutting tools, or tines, used on the Rototiller: A, the S tine; B, the curved knife tine; C, tine for shallow work; D, the pointed tine

been standardized. For deep penetration, the pointed tine (Fig. 2,D) was found to be the most efficient. The point of this tine enters the ground at an angle and causes it to dig in continually throughout its entire contact with the untilled soil on the tine circle, much like the point of a plow. Thus the action of this tine is to dig itself in and pull the entire tilling unit down. Depth control is, therefore, of greatest importance. Without it the tendency is to go deeper and deeper and beyond the power available.

In a cover crop that is tough and stringy, this type of tine will ball-up, hooking on to and retaining almost any kind of trash. This hook or pointed tine is used for deep soil preparation in clean ground, wheat stubble, and sod ground with cover crop removed, and should never be used in tall tough cover crops.

The curved-knife tine (Fig. 2,B) will not go as deep as the pointed tine. It tends to lift the entire tilling unit out of the ground, to cut or wipe off any tall cover crops and to shear the soil, as against the pick action of the pointed tine. For all general purposes, except where extreme depths or extreme fineness of tilth are required, this tine is used and recommended. Next to the pointed tine, it is the most efficient from the standpoint of power consumed and work done.

Fig. 2,A shows what is known as the S tine. Like the curved-knife tine, it will not dig deep. It will produce the greatest fineness of tilth, is more apt to clog up in a cover crop than the curved knife tine, but is desirable in stony and trashy ground.

For shallow work, scuffing the surface and destroying weeds, and mulch cultivating before the weeds have attained any considerable height, the tine illustrated in Fig. 2,C, is most effective.

The shape of these tines was first ascertained by years of trial and error. Then later engineering tests were made which proved their correctness.

Outside of the engineering work done by our own company and our European associates, the most exhaustive work along these lines was done at Iowa State College by Prof. Edgar V. Collins and a student, Richard K. Frevert. In 1931 we provided Professor Collins with standard springs and tines for experimental work at Ames, Iowa. Fig. 3 shows test apparatus made at the College for the

Fig. 3 This apparatus for testing the Rototiller was built at Iowa State College under the direction of Prof. E. V. Collins

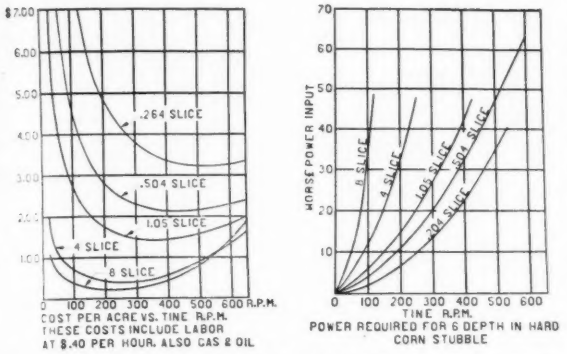

Fig. 4 In these graphs the 0.264, 0.504, and 1.05 slices were results obtained with the special test apparatus built by Professor Collins. The 4-in and 8-in slices are estimated from tests with the most recent designs with reduced tine circle and self-contained spring tine

purpose of determining the efficiency of rotary tillage. This apparatus had certain limitations. The tilling unit was driven from the side so that a small plow had to be provided to dig a furrow for the chain case in order to allow depth of tillage. The drum on which springs and tines were mounted was too big, providing a tine circle of large diameter, and therefore inefficient. The type of spring used for mounting the tines had a large frontal area causing a paddle-wheel effect necessitating rapid lifting of large amounts of soil, only to waste power. This apparatus was, however, worth all the time and money spent on it in proving several points.

Fig. 4 shows results obtained with this apparatus in corn stubble with the ground hard and dry to a depth of 5 in. Such results, however will vary greatly as conditions vary; the curves are intended to indicate trends rather than to present accurate data. To appreciate the action of a tine and its path through the soil, its relation to the forward motion of the tractor must be understood. This is shown in Fig. 5, which also shows the relative thickness of slice. It will be noted that the thickness of slice is not uniform but is at its maximum at the time the tine first strikes the ground and rapidly decreases to zero at the bottom of tillage depth.

The optimum tine-circle diameter for greatest efficiency has been determined at 1.25 to 1.50 times the depth of tillage. In practice, the mechanical requirements determine the diameter permissible, but the closer to this small diameter the tine circle can be constructed, the more efficient the tilling unit will be.

In our machine this diameter is determined by the diameter of the central housing which encloses the ring gear and the driving pinion that transmits the power to the tine, as shown in Fig. 6. Until recently the tine-circle diameter was always considerably greater than the diameter of the housing, where deep tillage was required, in order that the housing itself could drop down to the proper depth. This is illustrated in Fig. 7. Removal of the earth directly under the central housing has in the past been accomplished by the placement of a sharp blade that divides the slice of soil between the two innermost tines adjacent to either side of the housing and the plow depth shoes, which regulated the depth by positioning it by the depth bar c. By adjusting the point to dig in like a plowpoint, it would gradually pull itself down, and in doing this would decrease the angle of entry until it became a negative angle and would hold the tiller from going deeper.

This apparatus, developed in Europe prior to 1930, had many disadvantages. First, it produced a dragging action similar to a plow and would not permit tilling in extremely hard ground, and, second, trash would gather around it and accumulate until it would lift the entire tilling unit out of the ground.

On tractor-operated rotary tillers, the accurate regulation of depth on level and prairie farms is a simple matter. The boom or hoist that lifts or lowers the tilling unit is arranged with stops or screw adjustment that determines how deep the tiller can go. Entirely different conditions prevail where the ground is rolling with depressions and hills.

The standard type of Rototiller attachment becomes a part of the tractor. This is highly desirable permitting the tiller and tractor to be as readily maneuvered as the tractor by itself. It makes it possible to back into any corner with the tiller raised. Then when properly positioned, the tiller can be lowered and tillage started. This means that, in a field with a fence or wall around it, the entire area can be prepared for planting with no untilled corners or headlands. Every available square foot is prepared. The width of tillage is always wider than the wheel tread so there are no wheel or other marks; there are no projections that prevent tillage right up to the fence line.

Thus, as a unit part of the tractor itself, the rotary tiller reacts to all the motions of the tractor. When the front end of the tractor drops into a depression, the tiller unit will tend to lift out of the soil causing shallow or no tillage. On the other hand, if the front end of the tractor raises when starting to climb a grade, the tilling unit will be lowered tending to dig deeper. Under these rolling conditions, depth is controlled by simply hanging the tilling unit on a roller or compactor that rides directly back of and close to the tiller. Depth, therefore, is determined by the position of the roller in relation to the tiller, and is inde-

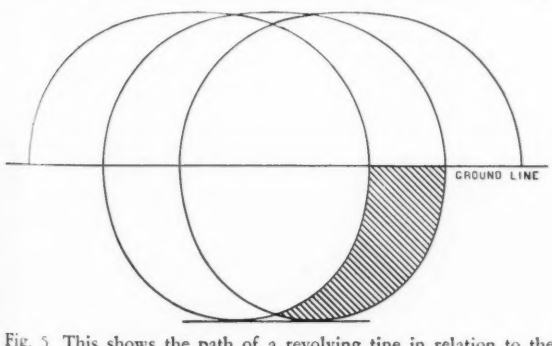

Fig. 5 This shows the path of a revolving tine in relation to the forward travel of the Rototiller

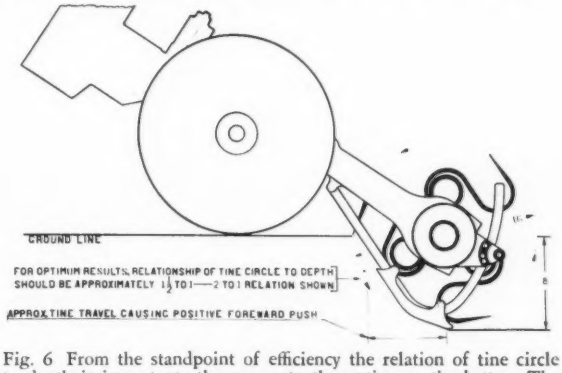
GROUND LINE
FOR OPTIMUM RESULTS, RELATIONSHIP OF TINE CIRCLE TO DEPTH
SHOULD BE APPROXIMATELY 1½ TO 1 — 2 TO 1 RELATION SHOWN
APPROX TINE TRAVEL CAUSING POSITIVE FOREWARD PUSH

Fig. 6 From the standpoint of efficiency the relation of tine circle to depth is important; the nearer to the optimum, the better. The relation shown here is good standard practice

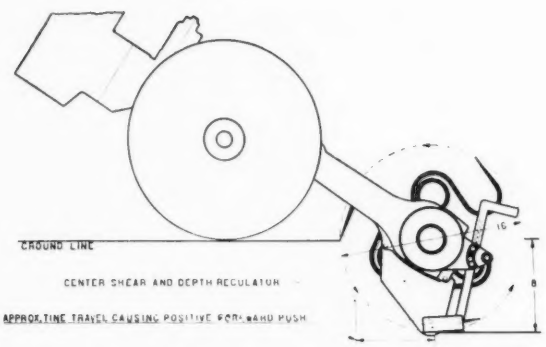

Fig. 7 This depth-regulating device, used on early Swiss and German machines, regulates depth with considerable accuracy. This is done by raising or lowering the handle and positioning it with a pin that goes through the holes shown. The action of this regulator is to pull the machine down until the entrance angle of penetration flattens out to zero degree. It works much like the point of a plow. The center shear is used to break the ground and throw it to either side under the central housing. In clean, easily tillable soil this is a satisfactory arrangement. When the ground is hard, the shear produces considerable drag, and if there is very much trash or cover crop in the ground, it will tend to wind up around this shear and lift the whole tilling unit out of the ground

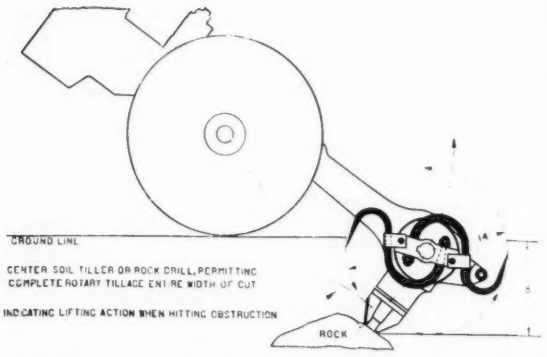
GROUND LINE
CENTER SOIL TILLER OR ROCK DRILL, PERMITTING COMPLETE ROTARY TILLAGE ENTIRE WIDTH OF CUT
INDICATING LIFTING ACTION WHEN HITTING OBSTRUCTION
ROCK

Fig. 8 This shows the most modern development in rotary tillage. The tine circle has been reduced. Due to the development of the new type tine, no center shear is required because the revolving rock drill completely tills directly under the center-drive section, permitting for the first time complete tillage from one end to the other. This revolving rock drill shreds any trash or cover-crop material that comes in contact with it. The only tendency to lift the tilling unit out of the ground is when this drill encounters very large obstacles such as shown. Under such condition, the tendency is for the whole tilling unit to be lifted out of the ground, in this way passing over the obstruction

pendent of the contour of the ground. Accurate depth control is simply a matter of allowing the tilling unit to go to the desired depth by adjusting the depth-control screw that regulates this relationship. This method of depth control was first used in Switzerland on small walking rotary tillers, and was then developed for riding tractor models by our company.

Our company was recently granted a patent covering the mounting of a rock drill under the central housing which overcomes entirely the inefficient dragging effect of the European design. This drill cuts up any trash that it encounters and has a tendency to lift the entire tilling unit out of the ground when encountering large stones or obstacles. It will till itself in regardless of soil hardness, which is illustrated in Fig. 8. This rock drill now permits for the first time complete rotary tillage for the entire length of the tilling unit, has increased the efficiency of the tilling unit, and makes it possible to go into all kinds of cover crops without balling up.

The invention of the rock drill under the central housing made possible a much smaller tine circle, thus increasing the efficiency and in turn causing more efficient tillage because of better tine mounting. In the Iowa State College tests, and up until very recently, tines were mounted on springs as illustrated in Fig. 9, in which will be noticed the small frontal area of the tine and a frontal area of spring five to six times as great causing five to six times as much soil to be lifted and thrown around, which means a consumption of power greatly in excess of requirements.

With the tine construction illustrated in Fig. 8, which is its own spring, there is no increase in frontal area over the diameter of the tine itself. Therefore, there is no additional power loss. Instead there is a corresponding increase in efficiency. A much larger section and stronger tine is now permissible having greater shock-absorbing qualities because of another of our recent developments known as the shock-absorbing drive. Between the motor and the drive pinion is mounted a flexible rubber cushion drive. There is no metal-to-metal connection. Instead there is a yielding coupling, the yield of which is multiplied by the gear ratio of the pinion and ring gear; thus a one-inch permissible yield in the coupling would be a four-inch yield when the drive ratio is four-to-one at the same diameter as the coupling on the tine circle and an eight-inch yield on the tine-circle diameter itself, providing the tine circle were twice the diameter of the shock-absorbing coupling. These recent inventions have greatly advanced the art of rotary tillage.

Another recent and important invention is the protection of the tiller drive housing from the abrasive action of sand and soil mixed with a cover crop. Housings in the past have worn out from this action. With the side protection disks illustrated in Fig. 9, no such wearing action can take place as these disks revolve with the grass and abrasive soils.

Experience and tests taught us that satisfactory performance under most difficult conditions can only be performed with a tractor speed of approximately 44 fpm. To overcome this slow speed, the width of tillage is increased. Most makes of tractors have a low speed of approximately 176 fpm or more. This speed *(Continued on page 182)*

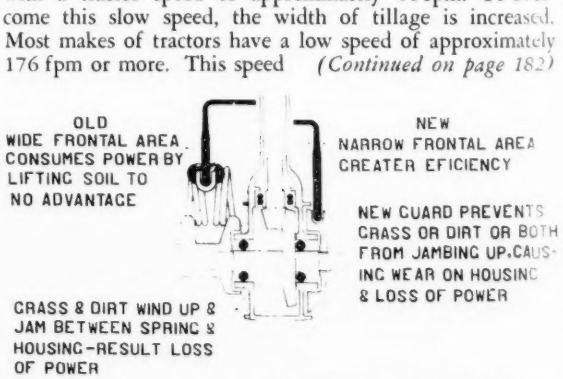

Fig. 9 This diagram shows the difference in tine mounting as now applied on heavy-duty Rototillers and the old mounting as still used on smaller models. The coil-spring mounting indicated on the left presents a large frontal area which lifts a large amount of soil and whirls it around after the cutting action has taken place. This consumes a considerable amount of power, whereas in the new narrow mounting of the tine, with the tine becoming its own spring, this frontal area has been greatly reduced thus increasing the efficiency of operation. This illustration also shows how, in former mountings, grass and other trash could wind around between the tine holder and the center-drive housing. This had a tendency to wind up tight and consume power besides wearing the housing itself out. The new construction completely overcomes both of these objections

Some Rotary Tillage Applications

By John M. Greene

AGRICULTURE has long sought means of speeding the tillage of soil. Variable growing seasons and inclemency and capriciousness of weather places a high value on any development which, in at least some measure, frees the farmer from a constant factor—the apparently irreducible hours of labor spent annually in tillage. Rotary tillage—the application of power-driven, rotating soil working tools—offers a most inviting approach to a solution, for units built for garden operations have long been in successful use. Moreover, the experience of users of these garden machines seems to indicate strongly that soil tillage by this method holds a number of correlary benefits in better seed germination, better moisture acceptance and retention and a general improvement in the soil. The development of a rotary tiller capable of handling large acreages, which would successfully meet a wide variety of crop and soil conditions and which would be reasonable in operating cost and investment offers a problem of considerable dimensions.

Concerned with better tillage methods, Mr. Harry Seaman as far back as 1921 had made a tentative experiment in the use of a potato digger as a tillage tool. This implement followed the potato rows, tilling a strip 24 in wide. The intervening space was left untouched except for later cultivation. The potato crop grown averaged about 30% better than that from adjacent fields.

In 1926 a successful two-row rotary cultivator was designed and built. The soil-working tools were rotary hoe sections made of cast iron, and since its use was for cultivation only, the machine was designed to work at a depth of 2 to 3 in.

In 1931 a walking model rotary tiller equipped with what are called coil spring tines, was designed. The unit was powered with a 4-hp, 2-cycle uniflow engine of Seaman's design. This tiller cut a strip 24 in wide, but in capacity was limited to truck gardening operations.

This paper was presented at a meeting of the Pennsylvania Section of the American Society of Agricultural Engineers at State College, Pa., October, 1945.

JOHN M. GREENE is associated with Seaman Motors.

In 1936 the U. S. Forest Service requested certain manufacturers to submit plans for a machine to kill white grubs which were infesting the soil of a number of the Service's nurseries in such concentrations that in some areas as much as half the nursery stocks were lost. Our company was one of the manufacturers invited to submit designs. Based on observations made of the work of our rotary tiller—a walking model—it seemed to us, and to the Forest Service personnel who had had experience with garden rotary tillers, that a machine operated by tractor power take-off would cope with the nursery problem and would afford a higher daily output of treated acreage than would be possible with the machine of earlier design. The destruction of the grubs, of course, is accomplished not only by actual contact with the soil working tines, but, more importantly, by impact against the hood where, with the soil, they are thrown with considerable velocity by the rotating tines. Our plans were accepted and a contract awarded to build nine machines.

A report of grub destruction issued March 19, 1940, by the Forest Service states that where the soil is tilled twice by this means, a 75 per cent mortality can be expected. The report adds that the majority of grubs are killed or so severely injured in the first tilling that they die quickly, but that it is important that the second tilling be done within an hour or two to kill the remaining larvae before they are able to move below the effective depth of the tines.

The Forest Service found additional use for the machines in the handling of compost piles. Formerly two to three years were needed before these piles comprised of soil, manure and peat moss reached the proper stage of decomposition.

By using the rotary tiller, these materials were spread in lifts or layers of a depth within the range of the tines. Soil, manure and peat moss were then thoroughly mixed together. As successive layers were added to the pile, the materials were mixed with the rotary tiller. It was found that by this means the compost was ready for use in a year instead of the two or three years formerly required. Experiments conducted later showed that in many instances the preparation of a compost pile could be eliminated. Peat moss and manure spread directly on an area to be tilled was

Left: A Seaman rotary tiller is shown here milling the soil and mixing in a top dressing of manure. The manure is uniformly mixed through the full tillage depth when the hood of the tiller is closed. The depth of mix can be controlled by the amount the hood boards are raised • *Right:* In this picture the rotary tiller is shown eradicating wild morning glory in a field of oat stubble. When the hood is not closed most of the stubble is placed on the surface of the ground

frequently found to be as effective, for all practical purposes, after being thoroughly mixed with the soil by the action of the tiller, as was the prepared compost.

At that time farmers in general were inclined to be skeptical of rotary tillage. The country was very slowly recovering from the depression and the thought of investment in new and relatively untried equipment was not welcomed. In the meantime our company had applied the same mechanical principle used in the tiller to in-place mixing of road materials for bituminous and for soil-stabilized highways. Great economies over the then accepted mixing practices were made possible with the tiller, and its acceptance in the road construction industry was rapid. The present highway machine differs only slightly from the tiller. As a matter of fact, the early machines were agricultural units. The difference today lies chiefly in the design and construction of the tines.

Military airfield construction in which stabilizing materials were used for the runways, taxiways and aprons grew enormously prior to and during the war. Our machine, known in this field as a "mixer", was widely used by the Army, Navy and Marine Corps in the building of airfield and military roads both here and abroad.

Toward the end of the war much publicity was given to surface mulching, shallow tillage, and similar practices. Faulkner's book, "Plowman's Folly" had a wider sale than most best selling novels. The controversy and the interest that ensued made a great many people distinctly aware of tillage problems, and unquestionably caused farmers to give more attention to new practices.

Furthermore, the problems presented by the acute farm labor shortage led farmers to view with hope equipment which might save man power and labor hours. And a not unimportant factor was the dearth of new tillage equipment of conventional types. These three psychological influences adventitiously coming together led to a much more immediate willingness to try farm-scale rotary tillage than would have otherwise been the case. I suppose the advance in acceptance within one year was as great as it would normally be in a five-year period.

This is a salutary condition for the cause of rotary tillage, but it also brings with it very serious problems and responsibilities. The very immediate problems are mechanical, for tillage conditions encountered in the loamy soils of much of the prairie lands of the Middle West are very different from some of the hard-baked soils in California. While mechanical aspects will be constantly improved, it is felt that the machine of today has successfully met the fundamental obstacles to a practical unit for large-scale tillage. Damage from rocks has been minimized by a resilient rotor construction and by the development of a "slip clutch" which allows any group or groups of tines to stop momentarily when an obstacle is met which offers resistance beyond that encountered in tillage.

We feel that the greatest problem is that of research to determine how far-reaching are the actual effects of rotary tillage—a determination of its benefits and of its limitations. Some research has been done, but, as far as we know, not in any co-ordinated way so that a complete evaluation can be made. We know that in certain specialized branches of agriculture, such as nursery operation, citrus and other fruit growing, muck farming and others, rotary tillage is highly desirable both from the standpoint of economy as compared with other methods previously employed and from the standpoint of direct benefit to the crops grown. We know of many such cases. One which comes to mind is that of a large potato grower who was good enough to supply us with photographs of a very interesting condition. A section of a large field was tilled by conventional means; the remainder was rotary tilled. A severe drought occurred after planting. The photographs show very strikingly indeed the dead and withered plants, the weed infestation and the small, dwarfed potatoes grown in the section handled by conventional tillage, as compared with the healthy plants and full-sized potatoes grown in the rotary-tilled section. The photographs were taken at the junction of the two areas and the line of demarcation is very pronounced.

None of this is scientific in the sense that data is specific, measured, weighed, and correlated against carefully established controls. It is, however, pretty indicative for it comes from the growers themselves, and since it concerns their pocketbooks, there is a strong tendency on their part toward dispassionate and careful observation of results.

But as I say, these matters concern rotary tillage and the specialty growers, and while they are important, we feel that there is great need for well-planned research in the field of general agriculture. There are a great many questions to be answered.

How much more moisture will rotary-tilled soil receive and hold? Of what types of soil is this true? How long under observed conditions of drought will that moisture be held? Is fall tillage needed when a rotary tiller is used? Is the soil compaction factor less in rotary-tilled land than in that tilled by other means? Is seed germination improved by rotary tillage, and if so, to what extent? Are crops grown in rotary-tilled land hardier, of greater yield and of earlier maturity? To what extent does the aeration factor in rotary tillage influence the nitrogen cycle?

A thorough study of rotary tillage implies research into many departments of soil science. It must certainly deal with the zoology, chemistry and physics of soil, and if I am correctly informed by those who make such studies a lifetime pursuit, there is much that remains unknown, or, at best, is still theoretical.

An interesting study would concern itself with the effect of finely divided organic matter, with consequently a greater surface area such as is mechanically produced by rotary tillage, on the fertilizing constituents of soil. Does this result in a temporary loss of those fertilizing constituents because of the work of decomposing the carbon of the organic material? Or does it result in a fast decomposition cycle which increases the humous content very rapidly? Perhaps less organic material added to the soil, but at more frequent intervals when rotary tillage is employed, may be more effective than present-day general practice. Perhaps less organic material applied at the usual intervals may be the answer. There does seem to be a feeling among many farmers that heavy applications of manure, for example, result in a temporary "freezing" of fertilizing effect until the work of breaking down the organic material has been accomplished, and nitrogen and other constituents are again available to the plant. If this is the case, there may well be a question of determining the organic limit of tolerance of soil under different methods of tillage.

We do not have the answers; we are merely suggesting some very interesting, and, we think, important avenues of research which those engaged in the science of agriculture might follow. We are not soil chemists, bacteriologists, or physicists—we are manufacturers. Such evidence as has come our way is hardly scientific. It comes to us in the words of the farmer, but we think it is nevertheless strongly indicative. We simply hope that such studies will be undertaken, for we feel very sincerely that they will be of great importance to agriculture.

A Proposed National Spokesman for Engineers

By A. B. Stickney

THERE are upwards of 200,000 engineers in this country sufficiently interested in engineering as a profession to have joined a society, but not over 10 per cent of them belong to any one society. There is a widely felt need of an over-all organization of all the societies to act as spokesman for all engineers on matters of common concern. On a local basis over 100,000 engineers in 35 metropolitan areas have organized themselves into local councils, and are doing an effective job of inter-societal cooperation within their sphere of activity. In the last few years much has been said and written about a similar organization on a national scale. Everybody wants it; everybody is talking about it; it's in the air; it's coming; it's inevitable. While it is no longer necessary to talk about why or whether there should be such an organization, there is no such unanimity about what it should be like. This paper outlines a proposed organization by answering four questions: who, how, what, and who will pay for it?

First, *who?* It should be built on the foundation that the American Standards Association has so effectively employed, namely, that anyone having a legitimate interest has an inherent right to participate. There are five types of organization which have that legitimate interest. They are:

1 The so-called founder societies — civil, electrical, mechanical, mining and metallurgical, and, included in recent year, chemical engineers. These societies have large memberships, and each embraces a whole field of engineering. Together they have perhaps 40 per cent of the engineers of the country on their rolls.

2 The specialized national societies. The agricultural, automotive, heating and ventilating, illuminating, radio, refrigerating, tool, and a host of other engineers, all have their own societies. While some of the members of these societies are also members of founder societies, there is a general disinclination to belong to more than one society, and a great many of them have dropped their founder society memberships because only an occasional paper or article was of significance to them, whereas in their specialized society a large part of the papers and other activities are of interest, and the closer contacts in the smaller groups are more stimulating. Beyond that, these societies generally have an associate grade of membership for the men who would not be eligible under the stricter rules of the founder societies, but who none the less practice engineering, and these men must be included in any organization undertaking to speak for engineers as a whole. Collectively, these specialized societies have a larger membership than the founder societies.

3 Local specialized groups, similar to the specialized national societies but not organized on a national scale. There are a number of such organizations in the various local councils, and they undoubtedly exist in considerable numbers in all the larger metropolitan areas.

4 The local councils, which are composed of the local sections of national societies and of local groups, so that membership is by virtue of membership in some other organization. A survey of the 35 then in existence was published by the Cincinnati council last April. This survey, by Mr. Frank Sanford, past-president of the Cincinnati council, has been widely publicized, and is available on request, so that no elaboration is required here.

5 The local engineering societies or engineers' clubs, which have individual membership but which cut across the field and have members with all varieties of specialties. Probably all cities of over 100,000, and a great many smaller cities, have them, and in a great many cities they are the only local organization of engineers, and provide the only direct contact a great many engineers have with others of their profession outside business hours.

Trade associations or organizations having predominantly company memberships should definitely not be included, since the object is to represent the interests of engineers as individuals. But the line must be carefully drawn here. Such societies as the American Society for Testing Materials with a combination of company and individual memberships should certainly not be excluded, at least as far as their individual memberships are concerned.

Whether technologists in other fields than engineering should be included is a moot point. Chemists, physicists, biologists, food technologists and the like are in several of the local councils. Probably they would not want to be included in a national engineering organization, but that is something for them to decide for themselves.

Second, *how?* A governing body for a national organization would be formed by having each member body select one representative for a period of three years, with the larger organizations having more than one representative, say, on a basis of major fractions of 5000. Thus a society or council with over 7500 members would have a second representative, one with over 12500 a third, one with over 17500 a fourth, and so on. Confining these representatives to men who have held general elective office, such as past-presidents, past-chairmen, past-vice-presidents, etc., would assure experienced, responsible talent. Terms would be staggered so that one-third were elected each year. These men, and there might be a couple of hundred of them, would form the National Council. It would elect its own officers and the members of standing committees. The Council would meet twice a year, and between times an Executive Committee composed of the officers and the chairmen of all standing committees would give effect to the decisions of Council. There would, of course, be a paid Secretary and staff.

In addition to the usual committees necessary to the carrying on of the business of the organization — Executive, Finance, Constitution and By-Laws, Nominating, Membership, etc. — there would be a standing committee in charge of each activity the Council undertook. Additional activities could be undertaken, and additional standing committees formed to supervise them, by, say, two-thirds vote of the entire Council membership at two successive meetings, which would mean that any controversial points could be discussed by the governing bodies of the member organizations, and their representatives instructed, before a final vote was taken. However, the President, with the approval of the Executive Committee, could appoint special committees having a limited term and advisory or temporary executive powers.

Third, and most important, *what?* This is the point

A. B. STICKNEY is past-president of the American Society of Refrigerating Engineers and currently chairman of its Committee on Relations with Other Organizations.

EDITOR'S NOTE: This paper, in whole or in part, is appearing in the April issues of other engineering society journals, including "Refrigerating Engineering", "Mechanical Engineering", "Journal of Engineering Education", and "The Welding Journal".

where most of the disagreement occurs. There are many things the National Council might concern itself with, and some of them will be enumerated shortly. But what do the majority of engineers — the men the Council will be spokesman for — want? Nobody knows, and nobody can know. The issues have never been laid before them; there is no mechanism for doing it. And right there is the answer to the question. *Create the mechanism, lay the issues before them, and find out what they want!* That's all that is necessary to start with, and it's a big job. When the wants are known, the mechanism will be at hand to do something about them, with the safeguard to prevent going off the deep end that there must be a two-thirds vote at two successive Council meetings, six months apart. After a few years there will be a variety of activities, but no one can predict today just what they will be. There are various cooperative activities going on today — to mention just one, the Engineer's Council for Professional Development — and if it is deemed desirable, these activities can be blanketed in as standing committees without any break in the continuity of their work.

What is the mechanism for finding out what is wanted? Start a magazine which will go to each of the individual members of each of the member organizations, by virtue of that membership, in addition to the publications of his own organization. Discuss the issues — present both sides — and let the membership of the various societies tell their representatives what they want.

The magazine would be divided into four main parts. The first part would be the policy articles — the social and economic status of engineers, licensing, collective bargaining, engineering education, pending legislation, standardization, sponsorship of research, patent policy, economic theory, national and international affairs, and similar subjects. Perhaps only 10 per cent will read the articles on any given subject, but 10 per cent of all engineers is in itself a large audience, and the rest will be proud to have the articles available, even if they don't read them. A magazine with the circulation we are talking about, going to all engineers, will be unique. There is nothing like it today, and it could command talent that none of the individual societies can touch. It will make it possible for the first time to lay before the entire profession the best thinking on both sides of issues of concern to engineers.

The second part of the magazine would be informative articles on engineering matters of general interest. It would be written from the standpoint of telling engineers what is going on in the engineering world outside of their own fields of specialization. Such things as regional planning; development, utilization and conservation of natural resources; flood control, city planning, super-highway system integration, new railway equipment, developments in radio, automotive engineering, frozen foods, new engineering materials and methods of their utilization, and the like, and also the technical matters which capture the public imagination from time to time and which the engineer feels he should know more about, such as nuclear physics and radar last year, would be discussed by authorities, but in a style which assumes only the basic engineering knowledge and viewpoint we all have, and popularizes the subject from there on. This type of article would have a tremendous popular appeal and a broadening influence on engineers' viewpoints and fields of knowledge which might well prove the most valuable thing to come out of the entire program.

The third part of the magazine would be the news of the organization and of the member organizations, and of engineers individually. It would include a series of write-ups of the member societies and councils, cross-sectional studies of how various societies solve organizational problems common to all societies, news of elections, meetings, activities of general interest, etc. News of individual engineers would be primarily from the standpoint of activities of interest to all engineers, or of activities outside the technical field, such as in civic affairs. A very important part of this section would be a forum in which the individual was encouraged to express himself on the issues being discussed or bring up new issues for discussion.

The fourth part of the magazine would be a combined index of the technical parts of the publications of all member societies, and perhaps of commercial technical journals as well, with the articles classified as to type (new contribution, survey, polemic, etc.) and a brief description where the content is not evident from the title, so that the individual engineer could find out about articles of interest to him which appear in journals he does not normally see. Means would have to be provided for him to see the articles after he found out about them. This section would also carry book reviews and notices of publications of general interest, such as indices of standards and the like.

Finally, *who is going to pay for it?* Let each member group pay a $1.00 subscription to the magazine for each individual member. Where a man is a member of more than one group, split the dollar. Where membership in one group is by virtue of membership in another group which is already in the National Council, there would be no charge. Beyond that, the advertisers will pay for it. The magazine will be an advertising medium with a circulation from both the quantitative and qualitative standpoints which will be very attractive, and after it is once going, the magazine should not only pay its own way but should yield a profit which will support other activities of the Council as they are authorized.

In conclusion, the Council of the American Society of Refrigerating Engineers has authorized the writer to sit on an organizing committee to formulate a specific proposal and invite attendance to a general organization meeting to give effect to such a scheme, and it has made an appropriation to help defray the expenses of such a committee. A number of other groups have been invited to do likewise, and it is quite possible that such a committee will be functioning within the next few months. The thought is to keep it small enough to function efficiently, and yet diverse enough so that its proposal will be generally acceptable, and will not represent domination by any group.

Engineering's Economic Environment

(Continued from page 170)

If these things were true, and we only propose them as plausible ideas for critical examination and possible rejection, the implications for support, direction, and pursuit of engineering work might be as follows: More fundamental research in the basic sciences of engineering, highly desirable; improvement of products and development of new products, profitable; lower production costs, important; increased labor efficiency and income, essential; reinvestment or new investment in multiplying existing production facilities, with little improvement, in lines already troubled with excess competition, surpluses, and high sales costs, — of extremely doubtful value and probably a direct, unwarranted "steal" from needed consumer buying power.

It has often been advocated that engineers explore more thoroughly the economic environment in which they and their developments must operate. Possibly one good starting point is experimental extension, amplification, or modification of the familiar economic laws, to apply specifically to some of the cause and effect relationships of engineering progress.

Questions about Farm Buildings

TO THE EDITOR:

CAN agricultural engineers and the farm buildings industry get away from a philosophy of defeat in solving the farm buildings problem? Can farm buildings be financed on their own merit as investments?

While agreeing with Long[1] as to the need of extensive farm building improvements, I do not agree with his proposal that "a system of long-time loans based on the farmer's ability to repay should be made available through one of the federal farm contact agencies." The basis of my objection is that there are ample funds in our banks to finance the farmer's sound investments, and that is where these loans should find their place. Financing the farmer is not a function of government but a responsibility of the community and its banks. They are already doing this extensively.

Can agricultural engineers define farm building requirements?

I have searched much literature on the subject, and have gone through all the copies of AGRICULTURAL ENGINEERING. I have talked with many of our most prominent leaders in the farm buildings field. I failed to find any unified specifications of actual building requirements to suit all the farmer's needs in the different states. Farm livestock are practically alike. Farm crops are a fixed factor. Feeding is a uniform practice. These then are standard, so why not the structures?

It appears that every agency with materials at all suitable for the purpose has its own plan of procedure and recommendation. This can be broken down further into as many dealers as carry the material, each of whom has his own ideas about the requirements for farm buildings. Even builders as a group propose structures to suit their own ideas rather than actual requirements.

Much of this rather vague plan of what the building should be, or the material which is to be used, goes back to the fact that replacements are on the basis of individual structures. It is generally accepted that the farmer needs a dairy barn, a milk house, or a beef barn, buildings for hogs, poultry, machinery, or silage and grain, that causes this condition. This is the most important item in making the need in this matter of farm buildings more definite.

All these different structures only prolong the agony of bringing this subject to a head where someone can determine the actual essential requirements by careful analysis of basic facts which are available. This is not so much a matter of geography as of economics. It is not so much a matter of a silo, a corn crib, or a hay shed, or what have you, as a lack of a positive plan for the farmer, a definite overall recommendation.

It is very rare that an entire group of buildings if this is what we want, will ever be built at one time. Here is where the shoe pinches. Every building man, or nearly every one, and every supplier of material, it seems to me, has an "axe to grind." He is thinking of *a* building, *a* single structure. Some have the idea in mind only as a means of furnishing the structure with facilities. Others have only a single element to furnish as a part of the structure. Some think in terms of insulation, some in terms of roofing, ventilation, framing, foundation, equipment, etc., etc.

Let me ask if this is ever going to produce the kind of building facilities actually required by the farmer as a means of reducing his costs of production? Farm buildings are a part of the farmer's overhead cost; they bear a part of the cost of producing farm products—whether livestock, livestock products, or crops. Every single factor of farm production is carrying a part of the cost of buildings, their original cost, their depreciation, and upkeep.

Why can't agricultural engineers strongly urge fireproof or fire-resistant construction, or better fire protection? We are not entirely dependent today on forest products as basic materials for farm use.

Anyone who has viewed a farm fire during the night will understand just what I mean. We are told that there is a farm fire about every fifteen minutes, night and day, every twenty-four hours in the states, year in and year out. This should then not put me too far off the beam on this score. Can we afford to neglect this much longer?

Is there any reason, except perhaps tradition, and that surely isn't engineering logic, that a single structure for all livestock cannot be worked out to suit the farmer's needs and help to reduce costs of production as suggested by Hanson[3]? How happy time-study groups should be to see chore time cut by large percentages in such a program. This is a cost-reducing item of great importance.

Let's go a step further. Why not set up a group of four or five vertical structures—silos, if you want to use the term—all in a line adjacent to and communicating with this building. Let's have a permanent loading or filling device, a carrier, operated so that material can be elevated and then discharged into ony one of them by merely pressing a button—one for silage, one for chopped hay, one for stover or straw for bedding, one for ear corn, and one with three or four divisions for small grain or concentrates. Each one could, no doubt, also be made to unload automatically by just pressing a button. It is not impossible. This would avoid climbing to the top of such structures twice a day and unloading into a cart the hard way, by hand, to feed by hand again therefrom, and save time and labor.

Here is one of the problems. Farm buildings are generally replaced in single units—a corn crib, a silo, a dairy barn, etc., etc. But let me ask: Why can't someone in the building fabricating business—for instance, the steel fabricator—develop a complete farm building plan, that he can make and supply it in units that fit together as they are needed? Why can't he say to the farmer: "Here is a good practical plan for your operations. It has the sanction and support of your college and its agricultural engineers. It contains all the elements that willl enable you to produce economically. We will supply this structure or any part of it, set it up on your farm and finance the proposition. You pay us by the month for this job, plus a reasonable cash down payment. You need not erect the entire building at one time. As the old buildings need replacement we will carry out our part of this project, and in a few years you will have the buildings of a modern farm production plant." Isn't this possible? I think it is.

Any group of good business men could do this on a basis that would afford maximum building facilities at minimum cost. Several agencies could no doubt handle such a plan. Even a farm home could be made a part of such a scheme. It could be put on a business basis that would have appeal to good farmers everywhere. Wouldn't this be a movement to aid in solving one of the major problems with which we are faced in a healthy agriculture?

F. N. G. KRANICK.

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[1] Long, J. D. Farm building construction, AGRICULTURAL ENGINEERING 26: 451, 1945.

[2] Ekblaw, K. J. T. The postwar farm structures situation. AGRICULTURAL ENGINEERING 26: 149, 1945.

[3] Hanson, E. L. A firesafe labor-saving livestock compound. AGRICULTURAL ENGINEERING 25: 417-418, 1944.

What St. Louis Has to Offer Agricultural Engineers

ASIDE from purely professional reasons for attending their next annual meeting, June 24 to 27, members of the American Society of Agricultural Engineers—and their families—will find many interesting things to do and see in the City of St. Louis. For example, Forest Park with its 1400 acres contains a number of picnic grounds, tennis courts, baseball diamonds, three golf links, etc. In this park also are the Municipal Open-Air Theatre, Art Museum, Jefferson Memorial, New Jewel Box, and several other public buildings. Incidentally, the evening of Tuesday, June 25, is to be an "open" evening at the A.S.A.E. meeting to permit those in attendance to attend the opera "Gypsy Love" at the open-air theatre.

This is a view of the union railway station in St. Louis, showing the Milles Fountain in action

Other attractions at St. Louis include Eads Bridge, Grant's log cabin, the Lindbergh trophies, the old court house, "Ol' Man River," Shaw's Gardens, and the Zoological Gardens. The St. Louis Zoo, by the way, is one of the world's most famous zoos. It is known as a model for the care of wild animals, and experts concerned with the captivity of wild animals have visited St. Louis from all parts of the country and abroad to study the ideal methods used there. One of the special attractions of the zoo is the daily wild animal show that is put on during the summer season.

One of the outstanding attractions of St. Louis is the Missouri Botanical Garden, popularly known as Shaw's Garden, which ranks second only to the famous Kew Gardens of England. It was founded in 1860 by Henry Shaw, a St. Louis philanthropist, and contains the largest collection of plant life in the western hemisphere, and is famous the world over for its wealth of botanical species and its beautiful floral displays. It comprises a city garden of about 75 acres and an out-of-town extension of more than 1600 acres.

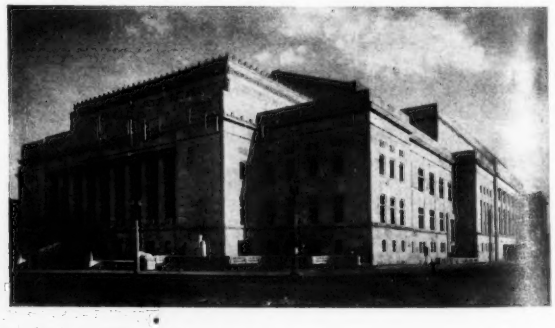
At the city garden large conservatories are maintained, which contain a varied collection of tropical plants and provide for an almost continuous display of chrysanthemums, orchids, lilies, and other blooming plants. Altogether more than 11,000 species of plants from all climes and all parts of the globe are to be seen in this garden.

One of the best botanical libraries in the country, one of the largest herbaria in the United States, laboratories for scientific work and a school for gardening combine the features of a pleasure ground with the facilities of an institution of research.

The out-of-town garden, which is rapidly being developed, is in one of the most favorable localities in the state for the growing of wild flowers and trees. Here, too, is carried on the propagation of rare and delicate plants away from conditions unfavorable to early plant life, incident to a city location.

Besides growing here much material for later exhibit in the city garden, there will gradually be developed an adequate arboretum. This development promises to become in time the most complete reservation for trees and other native flora in the temperate zone.

Those who attend the A.S.A.E. Annual Meeting at St. Louis in June will make their visit to the city more interesting and profitable if they make a special effort to see at least some of the city's many outstanding attractions.



Above: This old court house is one of the principal historical buildings of St. Louis, with the old slave market showing in the foreground • *Above, right:* The Kiel Auditorium in St. Louis, one of the principal public buildings of the city • *Right:* The Missouri Botanical Garden, popularly known as Shaw's Garden, is one of the wonder spots of St. Louis, and ranks second only to the famous Kew Gardens of England

NEWS SECTION

Program for Southwest Section Meeting

A MOST interesting program has been arranged for the meeting of the Southwest Section of the American Society of Agricultural Engineers to be held at the Blackstone Hotel in Fort Worth, Texas, on April 19 and 20.

Following the call to order and opening remarks by Section Chairman E. B. Doran at 9:00 a.m. Friday, April 19, a technical program will be presented with Howard Matson, U. S. Soil Conservation Service, presiding. The first two papers will be on drainage surveys in the Texas Gulf coast area by Roy L. Hauger, and problems in dam and spillway design by S. R. Sapirie, both with the U. S. Soil Conservation Service. At this point Roy E. Hayman will speak on the subject "The Bread Line Forms Here", following which there will be two papers, one on mole drainage investigations by I. L. Saveson, USDA drainage engineer, and the other on flame cultivation and cotton thinning by D. M. L. Forbes of the Fijelin Company.

Kyle Engler, secretary of the Southwest Section, will preside at the afternoon session which will open with a symposium on weed, brush, and tree eradication and control. V. V. Parr, SCS research engineer will lead the discussion. C. E. Fisher, agronomist of the Texas Agricultural Experiment Station will discuss use of chemicals; M. B. Cox, SCS agricultural engineer, will talk on the use of light mechanical equipment; and R. E. Hall of the Beeville Substation of the Texas Experiment Station will talk on the use of heavy equipment. General discussion will be led by M. R. Bentley, Texas Agricultural Extension Service.

Following a recess there will be three papers, one on developing a farm structures extension program by E. K. Rambo, another on new developments in farm mechanization by R. M. McCroskey, Dallas branch manager of the International Harvester Company, and a third on the place of the agricultural engineer in southwestern agriculture by C. N. Shepardson, dean of agriculture at the A. & M. College of Texas.

The Section dinner will be held at 6:45 p.m. of the same day, with Section Chairman E. B. Doran as master of ceremonies, and Dr. Mark L. Nichols, assistant chief (in charge of research) of the U. S. Soil Conservation Service, will be the dinner speaker.

At the forenoon session on Saturday, April 20, L. E. Hazen, Oklahoma A. & M. College, will preside. The program for the session includes a paper on a coordinated college farm electrification program by P. T. Montfort of the A. & M. College of Texas, another on grain drying investigations in Texas by W. E. McCune of the Central Power and Light Company, and a third on hay drying investigations in Texas by J. W. Sorenson of the Texas Agricultural Experiment Station. Following a recess Xzin McNeal of the University of Arkansas will present a paper on rice drying investigations in Arkansas, and H. P. Smith, chief of the division of agricultural engineering at the Texas Agricultural Experiment Station, will present a paper on late developments in mechanical cotton harvesting. Raymond Olney, secretary of A.S.A.E., will have a report from Society headquarters.

The meeting of the Section will close with a business session.

Farm Chemurgic Conference Reflects Postwar Problems

POSTWAR resumption of the annual chemurgic conferences was initiated with the assembly at St. Louis, Missouri, March 18, 19, and 20, of the 11th national conference on this subject, under the auspices of the National Farm Chemurgic Council.

The influences of current world food shortages and of governmental commodity controls colored the trend of expression in papers and discussion. Likewise, research and industrial war babies claimed attention. Notable among these were the plastics being synthesized from non-agricultural raw materials. In the food line, attention centered on chemurgic factors in plant, animal, and human nutrition, including vitamin values and trace-element factors.

Agricultural engineering contributions to and problems in chemurgic developments were referred to or implied at a number of points throughout the meeting, notably in connection with castor bean production, and incidentally in relation to production of brome grass, dill, quar, lemon grass, perilla, ramie, sage, sassafras, and sunflower.

One reported by-product use of particular interest in the mechanical industries was soft-grit blasting with ground corn cobs and rice hulls for safe cleaning of highly finished metal surfaces.

A.S.A.E. Meetings Calendar

April 19 and 20 — SOUTHWEST SECTION, Blackstone Hotel, Fort Worth, Texas.

June 24 to 27—ANNUAL MEETING, New Jefferson Hotel, St. Louis, Mo.

December 16 to 18 — FALL MEETING, Stevens Hotel, Chicago, Ill.

New Missouri Section Elects Wooley

THE organization meeting of the Missouri Section of the American Society of Agricultural Engineers was held on the campus of the University of Missouri at Columbia on March 15. About eighteen members of the Society in the state of Missouri attended the meeting.

J. C. Wooley, head, agricultural engineering department, University of Missouri, heads the list of officers of the new section. In addition to Mr. Wooley's election as chairman, three vice-chairmen were elected as follows: Paul N. Doll, Missouri state department of resources and development, W. A. Harper, Socony-Vacuum Company, and E. F. Clark, assistant sales manager, agricultural division, Butler Manufacturing Company. A. W. Zingg of the U. S. Soil Conservation Service and Paul M. Mulliken, executive secretary of the National Retail Farm Equipment Association, were elected to the Nominating Committee.

One of the major activities of the Section in the ensuing months will be active cooperation with A.S.A.E. members in St. Louis in carrying out the plans of the local arrangements committee for the Society's annual meeting to be held at St. Louis, June 24 to 27.

The Section also gave consideration to cooperative activities, especially joint meetings, with other organizations in the state, including the Missouri Farm Manager's Association, the Kansas City Tractor Club, and the St. Louis Farm Equipment Association.

Bither Elected Chairman, Pacific Coast Section

THE Pacific Coast Sestion of the American Society of Agricultural Engineers, at its 24th annuel meeting held in the Little Theater Municipal Auditorium at Sacramento, California, on February 26, elected Tom A. Bither, chief field engineer, California Corrugated Culvert Company, as its chairman for the ensuing year. H. C. Schwalen, professor of agricultural engineering, University of Arizona, and F. E. Price, head agricultural engineering department and assistant dean of the school of agriculture, Oregon State College, were elected vice-chairmen of the Section. Walter W. Weir, drainage engineer, division of soils, University of California, for many years secretary-treasurer of the Section, was re-elected to that office. Clyde Walker, agricultural director, tractor sales division, R. M. Wade and Company, was elected a member of the executive committee.

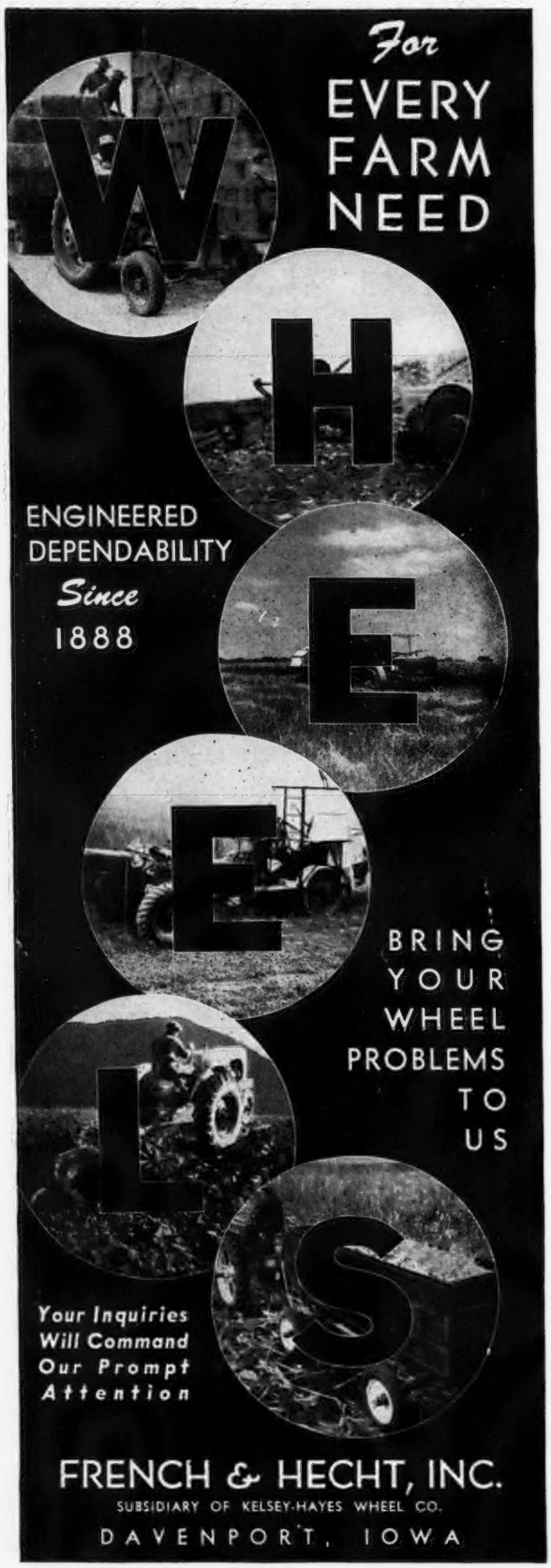
About seventy members and friends of A.S.A.E. attended the meeting and listened to an interesting technical program.

Schwantes to Represent A.S.A.E.

ON invitation from the Regents of the University of Minnesota to have a representative of the American Society of Agricultural Engineers at an educational conference celebrating the inauguration of the new University president, James Lewis Morrill, A.S.A.E. President J. Dewey Long has appointed, as the official representative of the Society, A. J. Schwantes, chief of the division of agricultural engineering, University of Minnesota.

Hienton to Head New Electrification Division

THE research work of the U. S. Department of Agriculture on developing new income-producing uses and application of electricity to farms and farm homes is centered in the Division of Farm Electrification, one of the several agricultural engineering divisions in the Department's Bureau of Plant Industry, Soils and Agricultural Engineering, and last month it was announced that Truman E. Hienton, a veteran of both World War I and II, who rose to the rank of colonel in the latter, would head the new



division. He will begin at once the work of setting up a complete new program of farm electrification projects in cooperation with the various states and in close collaboration with farm organizations and the farm and electrical equipment industries.

Mr. Hienton is a graduate of Ohio State University and holds a master's degree in agricultural engineering from Iowa State College. Prior to entering World War II he was in charge of farm rural electrification research at the Indiana Agricultural Experiment Station. During the war he served as director of supply for 12,000 troops in Iran for one year, and later he was civil affairs officer on Leyte and Mindanao Islands with the 10th Army Corps, supervising procurement and distribution of all civil relief supplies on Mindanao.

Committee on Fertilizer Application Reports

RECENTLY from G. A. Cumings, chairman of the Committee on Fertilizer Application of the American Society of Agricultural Engineers, has been received the Committee report for the year 1945-46, covering its individual work and its functions as part of the National Joint Committee on Fertilizer Application. (The latter committee is comprised of representatives of the American Society of Agronomy, the American Society of Horticultural Science, the Farm Equipment Institute, the National Fertilizer Association, and the A.S.A.E.)

During the war the Committee was devoting its attention largely to temporary expedients to facilitate the effective use of fertilizer notwithstanding the lack of new distributing equipment. With the return of peace, the Committee quickly shifted its objectives back to long-range research and equipment development.

As a part of the National Joint Committee, the A.S.A.E. Committee objectives are "(1) to coordinate research activities pertaining to methods of fertilizer application, and to the requirements of improved fertilizer distributing equipment; (2) to promote research, machinery developments, field demonstrations, and other activities designed to establish farm practices in which fertilizers will be applied in the most effective manner, and (3) to collect and compile current information bearing on fertilizer-placement developments."

In addition to its work as the A.S.A.E. representation on the National Joint Committee, the group operates as a committee of the A.S.A.E., with further objectives "(1) to organize and conduct specific research projects on the mechanical application of fertilizer; (2) to develop special fertilizer distributing machinery for use in crop experiments; (3) to aid research workers, implement manufacturers, farmers, and others in selecting, using, or designing improved fertilizer distributing machines, and (4) to direct the attention of qualified investigators to basic considerations in plant food utilization, and to otherwise aid in such research."

To carry out the foregoing objectives the Committee offers a program and program recommendations as follows:

"1 Establish and conduct research on fertilizer placement and other distributing machinery requirements, taking into consideration all important interrelated factors *(Continued on page 184)*

Rotary Soil Tillage

(Continued from page 174)

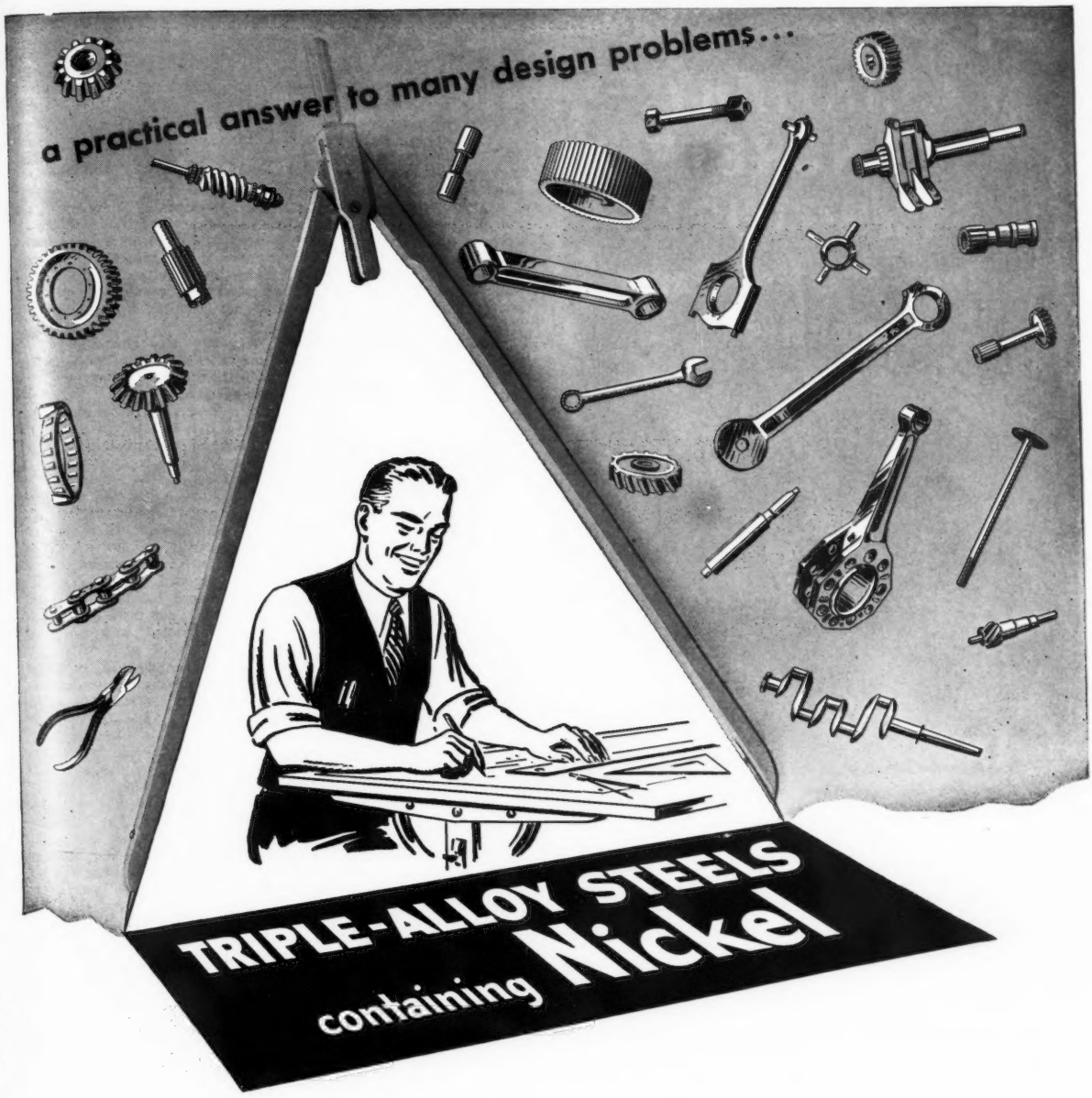
is much too great to do satisfactory, one-pass work under difficult conditions.

With the center tilling rock drill and new tine developments, it is now possible to make attachments for standard tractors that will do satisfactory work where the conditions are highly favorable. One of these recent developments has a 54-in cut and will till 6 in deep in a single pass. It uses the standard hydraulic lift on the tractor and can be readily attached or detached. This unit does an excellent job of trash-top shallow tillage as advocated by some authorities.

One of the new all-purpose tractors is the first to be equipped with a low speed of only 88 fpm. This permits satisfactory rotary tillage under almost all ordinary farm conditions. Width of tillage is 60 in and under favorable conditions 6 to 7 in depth can be accomplished in a single pass.

Our company is developing a third tillage attachment to fit an orchard type of general-purpose tractor.

With these developments and improvements, most of the desirable requirements of the eventual soil tiller have been met, and whether the grower is a believer in shallow surface tillage or deep tillage, this rotary tillage apparatus can be adjusted to give him just what he wants, and it can be easily and quickly removed from the tractor, so that the tractor can be put to other use.



Triple-alloy steels containing Nickel offer designers the following *triple* advantages:

1. OUTSTANDING PERFORMANCE—Strength and toughness, resistance to wear, fatigue or shock to meet a wide range of requirements, as dictated by design.
2. RELIABILITY—based on consistently uniform response to heat treatment.
3. ECONOMY—resulting from standard compositions precisely graded to match the engineers' needs.

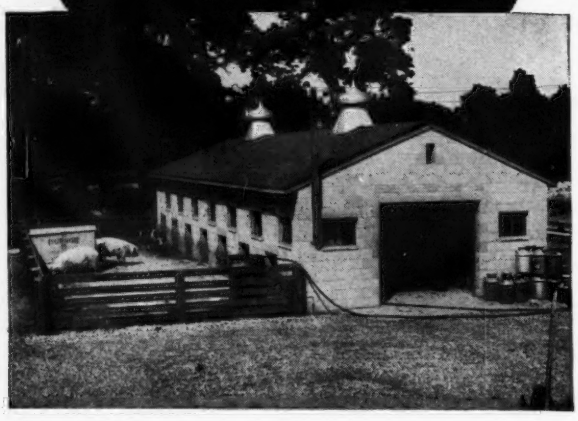
Service records established by triple-alloy steels over a period of years show that they are giving excellent results in many diverse and exacting applications.

The large number of standard compositions available, including the 4300, 8600, 8700, 9300 and 9800 series, permit accurate and economic selection for specific uses.

Because of their many advantages, these triple-alloy steels warrant your careful consideration when planning new or improved designs. We shall be glad to furnish counsel and data upon request.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 Wall Street New York 5, N. Y.

SANITARY CONCRETE STRUCTURES
Increase Hog Farm Profits!



More pigs per litter can be raised with a modern concrete hog house and feeding floor like this plant in Illinois.

A CLEAN concrete hog house and feeding floor give little pigs a healthy start—help them turn into marketable hogs faster with less feed.

A concrete hog house makes it easier to maintain the degree of sanitation necessary to prevent dangerous swine diseases. Concrete feeding floors are not only easy to clean but save expensive feed from being lost in the mud.

Write for illustrated booklet, "Modern Hog Farm Improvements". Free in United States and Canada.

PORTLAND CEMENT ASSOCIATION

Dept. 4-1, 33 West Grand Avenue, Chicago 10, Illinois

A national organization to improve and extend the uses of concrete . . . through scientific research and engineering field work

(Continued from page 182)

having a bearing on maximum crop production. Particular attention should be given to deeper application of all or a portion of the fertilizer, to higher rates of application, and the increased use of nitrogen and other materials.

"2 Emphasis should be placed on various means of expanding the use of improved methods and approved equipment now available, as well as creating improved machinery based on the knowledge of proven requirements.

"3 Either an evaluation or further development of new methods and equipment already introduced should be undertaken, including deep application of fertilizer by means of attachments on deep tillage cultivators and subsoilers, spreading of liquid materials with field machines, direct handling of lime and fertilizer from the railway car to the land by transport trucks equipped with spreader attachments, and equipment for placing fertilizer on pastures, hay land, and orchards.

"4 Increased attention should be given to standardization of the numerous types of distributing machines and functional parts, which would also include arrangements for more universal (and interchangeable) use of hoppers and machines."

Each member of the Committee is concerned with some part of the program through his regular duties, and is given related assignments. Observations are recorded and assembled within the Committee to show the activities, accomplishments, trends, and new problems.

Serving on the Committee with Mr. Cumings are C. J. Allen, J. P. Fairbank, G. W. Giles, H. V. Hansen, F. A. Kummer, G. B. Nutt, J. A. Slipher, H. P. Smith, R. W. Trullinger, C. H. White, R. H. Wileman, W. L. Zink, and C. H. Zirkel. f f

"From 1929 to 1944 inclusive, 1694 fertilizer placement experiments with 54 crops in 46 states were recorded.

"Fertilizer consumption has increased and has been extended into new areas due to high crop prices and profits, with a resultant demand for improved fertilizer distributors and new types of machines.

"New equipment includes attachments for deep-tillage cultivators, improved feeder and spreader mechanisms on attachments for transport trucks, field machine attachments for releasing anhydrous ammonia in furrows, and new spreaders and combination seed and fertilizer drills.

"Fertilizer-placement demonstrations are conducted on an extensive scale because visual proof of advantages of new methods and machines is essential in many cases.

"Activities reported by Committee members include development of a special self-propelled machine for fertilizer research, comparative study of one and two-band placement for corn, and study of deep placement for rice. Interest has been indicated in non-choking furrow openers, drills for subsurface applications on pasture, and equipment for metering and applying liquid fertilizers.

"Results of fertilizer application research over a period of years are reported to include increased efficiency in use, increased consciousness of the importance of proper methods of application, interest in further improvement of machines and methods of placement, and realization that placement, kind, amount and other factors must be properly balanced to secure maximum fertilizing results."

Proceedings of the National Joint Committee on Fertilizer Application for the year 1944 were published in February, 1946. The size of the volume (204 pages) reflects continued growth of interest in the subject. The volume includes an evaluation of deep placement, including plow depth placement.

Personals of A.S.A.E. Members

Robert A. Breckinridge, who has been engaged as a junior engineer on the USDI Bureau of Reclamation Project at Yakima, Washington, has been transferred to the Bureau's Deschutes Project at Bend, Oregon. With the transfer he now has the title of hydraulic engineer.

John M. Chambers has been transferred from Detroit to the plant of Harry Ferguson, Ltd., at Coventry, Warwickshire, England, where he is assistant chief engineer and is engaged on design work.

John F. Cykler is in new work as instructor and research assistant in agricultural engineering at the University of Wyoming and the Wyoming Agricultural Experiment Station at Laramie.

John B. Dobie, formerly investigator for the Washington State C.R.E.A, has undertaken similar work in California and will be connected with the division of agricultural engineering at University of California at Davis.

Joe S. Haucks, engineer, development department, Goodyear Tire & Rubber Co., has been transferred from the company's Akron office to its branch at Gadsden, Ala. *(Continued on page 186)*

It is the *combination* of features *plus added advantages* that make this new pillow block a noteworthy example of how ORCO engineers are contributing to produce improvements in diversified industries.

1. Automatic alignment of shaft is provided under such variable conditions as fluctuating loads, bent shafts, shaft whip, end and radial thrusts, unbalanced torque, variable belt pull, or any structural changes caused by wear, variations in temperature, shifting or settling of the base on which the pillow blocks are mounted, etc.
2. Rust-resistant, rigid metal housing.
3. Permanently grounded to eliminate arcing and radio interference under all conditions.
4. Long life, sintered metal bearing.
5. Positive lubrication. Oversize oil reservoir. No wick to pull the oil supply from the bearing if the oil level becomes low.
6. Adequate dissipation of frictional heat.
7. Vibration-absorbing rubber ring made of special heat and oil-resistant rubber compound.
8. Ease of installation and removal of bearing provided by the two-piece metal housing.

SUGGESTION: Investigate this new ORCO self-aligning pillow block for future applications. Sorry that present demand makes it impossible to accept new orders which specify firm delivery dates.

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Personals of A.S.A.E. Members

(Continued from page 184)

Arlon G. Hazen has accepted appointment as associate agricultural engineer at the Williston Irrigation Substation, North Dakota Agricultural Experiment Station, at Williston, N. D. He recently returned to civilian life after serving in the 819th engineers battalion (aviation) of the Corp of Engineers of the Army, in which he attained to the rank of lieutenant colonel.

Ernest M. Johnson has accepted employment with the Rural Electrification Administration, USDA, in Washington. He was recently released from the U. S. Naval Reserves with which he served as a lieutenant during the war period.

Harry Leonhardt was recently released from the Army and has returned to civilian life; he served with the infantry for two years in the India-Burma theater attaining the rank of major. He has again become associated with the U.S. Soil Conservation Service as an agricultural engineer with headquarters at Tucumcari, New Mexico.

William E. Meek, for a number of years special representative on tillage and seeding machine sales for International Harvester Company in the Southeast, has resigned to accept appointment as agricultural engineer at the Delta Branch Station, Mississippi Agricultural Experiment Station, at Stoneville.

George C. Merkel, formerly employed as assistant agricultural engineer, U. S. Soil Conservation Service, at Bethany, Missouri, is now supervisor of rural electrification for the United Light and Power Service Company at Davenport, Iowa.

Weldon O. Murphy was relieved from active duty in the armed services February 4, and is now employed in the service division of Harry Ferguson, Inc. His address is 12686 Cheyenne St., Detroit 27, Michigan.

Russell H. Reed, formerly associate in agricultural engineering at the Illinois Agricultural Experiment Station, recently joined the agricultural engineering staff at the University of Wisconsin as research associate and leader of a special project on the use of electricity on the dairy farmstead, a cooperative project between the University of Wisconsin and the Wisconsin Utilities Association. During the war Mr. Reed served in the ordnance department of the Army attaining to the rank of lieutenant-colonel.

William D. Scoates, who served as a lieutenant in the Weather Wing of the U. S. Army Air Forces during the war, is a civilian again and has accepted a position with the Texas Engineering Experiment Station at College Station.

A. B. Skromme is a field engineer specializing in brakes and clutches for the Auto Specialties Mfg. Co., St. Joseph, Mich. He was previously a development engineer for Firestone Tire and Rubber Co.

John P. Spielman now has a position as agricultural engineer in the Rural Electrification Administration, USDA, at Washington, D. C., having recently been released from the Army Air Forces in which he attained the rank of captain during the war.

G. H. Stewart, who served as a captain in the Signal Corps of the Army during the war, has returned to civilian life and is now employed as a rural electrification specialist by the South Carolina Agricultural Extension Service.

Archie A. Stone, who has been serving as chief of the Farm Equipment and Tractor Section of the Office of Price Administration, was recently promoted to the position of associate agricultural relations adviser to the Price Administrator. His new work will permit him to continue his close relations with the Farm Equipment and Tractor Section, but will also enable him to contribute to many other problems affecting agriculture, as it is in effect an active liasion agency between representatives of agriculture and OPA.

Harold E. Stover, who served as a major in the Coast Artillery of the Army during the war, has received his discharge and is now employed as extension agricultural engineer at Kansas State College.

Arthur W. Turner, assistant chief, USDA, Bureau of Plant Industry, Soils and Agricultural Engineering, and in charge of the agricultural engineering divisions of the Bureau, addressed a joint meeting of the Ontario Plowman's Association and the Ontario Crop Improvement Association at Toronto on February 12, on the subject "Trends in Tractor Farming", and on February 14 in the same city he addressed the Ontario Association of Agricultural Societies, on the subject "Engineering Advancements on the Farm and in the Home."

J. Arthur Weber was recently appointed an assistant in agricultural engineering research at the University of Illinois, having recently secured his release from the Army.

BE WISE, "MOBILE-IZE!"

You can increase efficiency and simplify operations of almost any type of equipment by making it portable. Investigate the uses of EWC Wheels, Axles, Springs, Tongues, etc., to give equipment added value.

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The Farmer Sees More . . He Does More

THERE are a lot of features that contribute to the easy handling of a Massey-Harris Tractor . . . features that make for more and better work, in less time, with less effort.

Not the least of these advantages is the complete, clean view he has of his work. Everything is right before his eyes . . . where he can see it without bobbing his head from side to side or craning his neck. The reason is the placing of structural members on the cultivator, for instance, outside his line of vision . . . the tapered design of the tractor hood . . . the high location of the seat. And the result is a better job . . . more acres covered . . . less fatigue at the end of the day.

Naturally you would expect practical features like this from an organization that for almost a hundred years has pioneered in the building of advanced farm equipment. This "know how" developed straight through separation, rasp-bar cylinders, and the self-propelled principle in combines . . . power-plus tractors with reserve power . . . Forage Clippers . . . dual caster wheel tractor mowers . . . and other outstanding advancements.

Keep your eye on Massey-Harris. Get acquainted with the Massey-Harris dealer in your community. He will be glad to give you any information you want on the complete line of Massey-Harris Farm Equipment.

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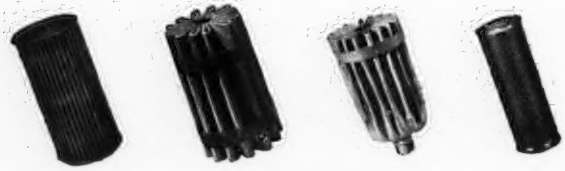
ANY TRACTOR WILL RUN BETTER and run longer when its bearings and other moving parts are protected by a Purolator. Purolator tractor filter elements are specially designed to keep tractor oil free from abrasives. Leading tractor manufacturers recommend Purolator filter elements exclusively. Don't accept substitutes—insist on the *original* and *genuine* Purolator filter replacement elements specially designed for your make of tractor. If it's a Purolator, it's the right filter element. Purolator Products, Inc., Newark 2, N. J. In Canada: Purolator Products (Canada), Ltd., Windsor, Ont.



KEEP OIL FREE FROM ABRASIVES WITH

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THE OIL FILTER

New TVA Publications

SEVERAL new leaflet publications recently released by the Tennessee Valley authority as special report numbers 27 to 32 are: "Drying Grain with Heated Air," by George E. Zerfoss; "Trailer Thresher;" "Truck and Pasture Irrigation (supplemental)," by J. M. Culpepper and W. H. Dickerson, Jr.; "Barn Hay Drying," by George E. Zerfoss and W. H. Dickerson, Jr.; "Electric Heat for Curing and Storing Sweet Potatoes," by George E. Zerfoss and Nolan Mitchell; and "Kitchen Flour Mill and Small Feed Grinders with Automatic Feeder." All cover work of the agricultural engineering development division of TVA.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send inforamtion relative to applicants for consideration of the Council prior to election.

Frank L. Abbott, assistant agricultural engineer, Central Vermont Public Service Corp. (Mail) Box 53, Ascutney, Vermont.

Kenneth V. Anderson, district agricultural engineer, Central Vermont Public Service Corp. (Mail) Box 31, Brandon, Vt.

Wilbur A. Busing, service division, Harry Ferguson, Inc., 15020 Woodward Ave., Detroit 3, Mich.

Perley H. Chamberlin, district agricultural engineer, Central Vermont Public Service Corp. (Mail) Bradford, Vt.

George D. Clyde, chief, division of irrigation, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box D, Logan, Utah.

Chester F. Culp, design and test engineer, Hartzell Propeller Fan Co., Piqua, Ohio. (Mail) 816 W. High Street.

Roy B. Davis, Jr., rural electrification research, Virginia Agricultural Experiment Station, Blacksburg, Va. (Mail) Box 465.

Wyburn C. Dozier, special representative, tillage and seeding machinery dept., International Harvester Co. (Mail) Donalds, S. C.

Erwin G. Dueringer, assistant manager, farm management, Do-Well Agricultural Service, First National Bank Bldg., Champaign, Illinois.

Merle L. Esmay, extension agricultural engineer, Extension Service, South Dakota State College, Brookings, S. D.

Perry F. Gifford, farm job analyst, U. S. Department of Agriculture. (Mail) Colorado A &. M College, Fort Collins, Colo.

Wilbur L. Griebeler, assistant agricultural engineer, Oregon State College, Corvallis, Ore.

J. W. Holmgren, equipment farm production specialist, General Electric Supply Corp. (Mail) 174 E. Sixth St., St. Paul 1, Minn.

Herbert B. Howell, superintendent, J. J. Astor Branch, Oregon Agricultural Experiment Station. (Mail) RR. No. 1, Box 921, Astoria, Oregon.

Erwin R. Johnson, research work on dairy barn equipment, International Harvester Experimental Farm, Hinsdale, Ill.

James O. Jones, instructor in agricultural engineering, University of Tennessee Junior College, Martin, Tennessee.

James B. Loonan, 104 Mound Street, Lebanon, Ohio.

Kenneth B. McPherson, rural engineer, Nashville Electric Service, 605 Church St., Nashville 3, Tenn.

James L. Montague, Jr., rural electrical development representative, Tennessee Valley Authority. (Mail) P. O. Box 911, Jackson, Tenn.

C. C. Pennington, president, Pennington Manufacturing Co., 472 No. Austin Blvd., Oak Park, Ill.

Arnold Pitt, chief research engineer, Massey-Harris Co., Ltd., 915 King St., West, Toronto, Ont., Canada.

Malcolm E. Sergeant, assistant agricultural engineer, Central Vermont Public Service Corp. (Mail) 38 Church St., Poultney, Vt.

Herbert R. Sinnard, associate professor of agricultural engineering, Oregon State College, Corvallis, Oregon. (Mail) 137 North 27th St.

Wilbur Travis, agricultural engineer, Puget Sound Power and Light Company. (Mail) 3030 Colby Ave., Everett, Wash.

Reginald L. Vassar, Rural Electrification Administration, U. S. Department of Agriculture, Washington, D. C. (Mail) 1758 M. Street, N. W.

Harold K. Wilson, southwestern representative, Douglas Fir Plywood Assn. (Mail) 427 Chamber of Commerce Bldg., Los Angeles, California.

TRANSFER OF GRADE

Robert F. Skelton, assistant engineer, design and development, Belle City Mfg. Co., Racine, Wisconsin. From Junior Member to Member.

A. J. Sprecker, district engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Kiowa, Colo. From Junior Member to Member.

Steel Takes a Beauty Bath

Imagine steel, the most masculine of metals, being concerned about its good looks. But it makes a difference to a farmer — when this steel is the metal used in his combine, corn-picker, grain drill or other farm equipment.

Here's why. You've seen paint peel and flake off ordinary galvanized sheets in farm machinery. The raw zinc has dried out the paint oils — costing the farmer many needless dollars for repainting.

Armco research engineers found out how to stop this early paint failure. The photograph shows a long galvanized steel sheet sliding into a special chemical bath which puts a tight insulating film over the shiny zinc coating. After this *Bonderizing* process the sheet will take and preserve paint. Weather-exposure tests prove that paint on ARMCO PAINTGRIP Steel lasts several times longer than on ordinary galvanized steel sheets.

ARMCO Galvanized PAINTGRIP is one of many special-purpose steel sheets that have made Armco the leader in the field of special-purpose steels. Armco works closely with manufacturers to assure the utmost in attractive appearance and long life for the sheet metal parts of farm machinery and equipment. That's why for 32 years the familiar Armco triangle trademark has been the trusted guide to extra quality in special-purpose sheet steel. The American Rolling Mill Company, 751 Curtis Street, Middletown, Ohio. Export: The Armco International Corporation.

ARMCO

The American Rolling Mill Company **Special-Purpose Sheet Steels**

Powered by a Model AKS 4-cycle, single-cylinder Wisconsin Air-Cooled Engine, this Porto Pump Fire Fighter, made by Product Engineering Service, of Detroit, Mich., provides an exceptionally efficient means for combating forest fires as well as fire protection for saw mills, paper and pulp mills, mines, farms, camps and isolated communities.

Weighing only 85 pounds, the Unit may be back-packed by a single person and strapped to any convenient tree, pole or post for fire duty. Delivers in excess of 43 gals. of water per minute at 100 lbs. pressure and has a suction lift of 31 ft. Set for a maximum pressure of 165 P.S.I.

Just another example of Wisconsin Air-Cooled Engine adaptability to a wide range of equipment and service applications.

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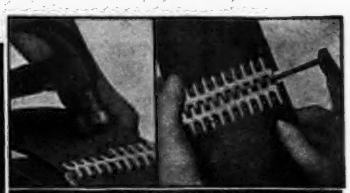
MILWAUKEE 14, WISCONSIN, U. S. A.
World's Largest Builders of Heavy-Duty Air-Cooled Engines

BELT LACING and FASTENERS for transmission and conveyor belts


"JUST A HAMMER TO APPLY IT"

ALLIGATOR
Trade Mark Reg. U. S. Pat. Office
STEEL BELT LACING

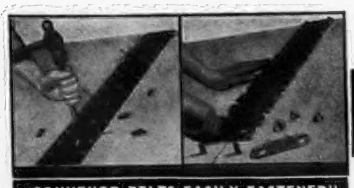
World famed in general service for strength and long life. A flexible steel-hinged joint, smooth on both sides. 12 sizes. Made in steel, "Monel Metal" and non-magnetic alloys. Long lengths supplied if needed. Bulletin A-60 gives complete details.

FLEXCO HD
BELT FASTENERS AND RIP PLATES

For conveyor and elevator belts of all thicknesses, makes a tight butt joint of great strength and durability. Compresses belt ends between toothed cupped plates. Templates and FLEXCO Clips speed application. 6 sizes. Made in steel, "Monel Metal", non-magnetic and abrasion resisting alloys.

By using Flexco HD Rip Plates, damaged conveyor belting can be returned to satisfactory service. The extra length gives a long grip on edges of rip or patch. Flexco Tools and Rip Plate Tool are used. For complete information ask for Bulletin F-100.

Sold by supply houses everywhere


"CONVEYOR BELTS EASILY FASTENED"

FLEXIBLE STEEL LACING CO.
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Chicago, Ill.

Personnel Service Bulletin

The American Society of Agricultural Engineers conducts a Personnel Service at its headquarters office in St. Joseph, Michigan, as a clearing house (not a placement bureau) for putting agricultural engineers seeking employment or change of employment in touch with possible employers of their services, and vice versa. The service is rendered without charge, and information on how to use it will be furnished by the Society. This bulletin contains the active listing of "Positions Open" and "Positions Wanted" on file at the Society's office, and information on each in the form of separate mimeographed sheets, may be had on request.

NOTE: In this Bulletin the following listings still current and previously reported, are not repeated in detail, except in two cases (W-291 and 298) in which changes in copy have been made. For further information see the Personnel Service Bulletin in AGRICULTURAL ENGINEERING for February, 1946:

POSITIONS OPEN: O-412, 430, 448, 452, 458, 464, 465, 471, 474, 479, 480, 481, 483, and 484.

POSITIONS WANTED: W-200, 201, 207, 208, 209, 210, 211, 213, 214, 215, 216, 217, 220, 223, 226, 227, 228, 229, 230, 231, 233, 234, 235, 242, 243, 246, 248, 250, 254, 259, 267, 270, 271, 274, 280, 282, 289, 292, 293, 295, and 296.

POSITIONS OPEN

DISTRICT AGRICULTURAL ENGINEERS (2 positions) for educational and service work in agricultural engineering, mainly farm machinery, structures, and drainage, in district of four or five counties. Northeastern state university. Start at $2500. O-488

AGRICULTURAL ENGINEER (assistant professor rank) for college teaching and extension. Northeastern state university. Salary $2700 to $3600. O-489

SALES ENGINEER for sales and advertising covering national distribution to retailers of well known specialized line of farm equipment. Midwestern manufacturer. Salary open. O-490

AGRICULTURAL ENGINEER, for extension work in farm machinery, soil and water conservation, and rural electrification in midwestern state college. Salary open. O-491

AGRICULTURAL ENGINEER (instructor or assistant instructor rank) for teaching farm mechanics and other agricultural engineering subjects in a pacific coast state polytechnic institute which is adding to its curriculum in these subjects. Salary range $230 - $340. O-492

FELLOWSHIPS (2) for recent agricultural engineering graduates released from the armed services, or 1946 graduates, providing opportunity to complete requirements for an advanced degree in two years. One is teaching fellowship in farm shop and power machinery. One is research fellowship for work on farm structures, or possibly electrification. Northwestern state college. Salary $900 plus veterans' educational benefits. O-493

POSITIONS WANTED

AGRICULTURAL ENGINEER (B S deg) desires sales or service work with private company serving agriculture, or in soil conservation or extension work. Long experience in engineering, engineering administration, sales, and promotion work in soil and water conservation field. Veteran of World War 1. Age 57. Salary $3500 min. W-232.

AGRICULTURAL ENGINEER (B S deg) desires design, development, and research work in rural electrification field for private company or government agency. Age 24. Salary $200 to $250 per mo. W-237

AGRICULTURAL ENGINEER (B S deg) desires development, research or sales and service work in power and machinery with private company, or soil and water conservation work with federal agency. Age 25 Salary $3000. W-238

AGRICULTURAL ENGINEER (B S deg) desires farm machinery sales or service work with private company. Age 23. Salary open. W-239

AGRICULTURAL ENGINEER (B S deg) desires farm machinery sales work with private company. Age 27. Salary $300. W-240

AGRICULTURAL ENGINEER (B S degs in agricultural and mechanical engineering) desires research, design, development, or sales engineering work in power and machinery for private company or in public service. Age 34. Salary $3800. W-241

ELECTRICAL ENGINEER (B S deg) desires promotion or operational work in rural electrification field, in midwestern location Age 25. Salary $3000. W-247

AGRICULTURAL ENGINEER (B S deg) desires rural electrification work, with private company or in public service. Age 28. Salary $2500. W-249

AGRICULTURAL ENGINEER (B S deg in M E) desires agricultural engineering work in Sacramento Valley, Calif. Age 29. Salary $3000. W-251

AGRICULTURAL ENGINEER (B S and M S degs) desires research or development work in rural electrification in Rocky Mountain or west coast area. Age 31. Salary $3000. W-253

AGRICULTURAL ENGINEER (B S deg) desires sales engineering or service work with private company in power and machinery or product processing field. Age 25. Salary $3000. W-255

AGRICULTURAL ENGINEER (B S deg) desires work in soil and water conservation, irrigation, or drainage. Age 36. Salary $3600. W-256

AGRICULTURAL ENGINEER (B S degs in agriculture and agricultural engineering) desires sales, sales engineering, or service work in farm machinery field, with private company. Age 29. Salary $250 per mo. W-257

(Continued on page 192)

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(Continued from page 190)

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